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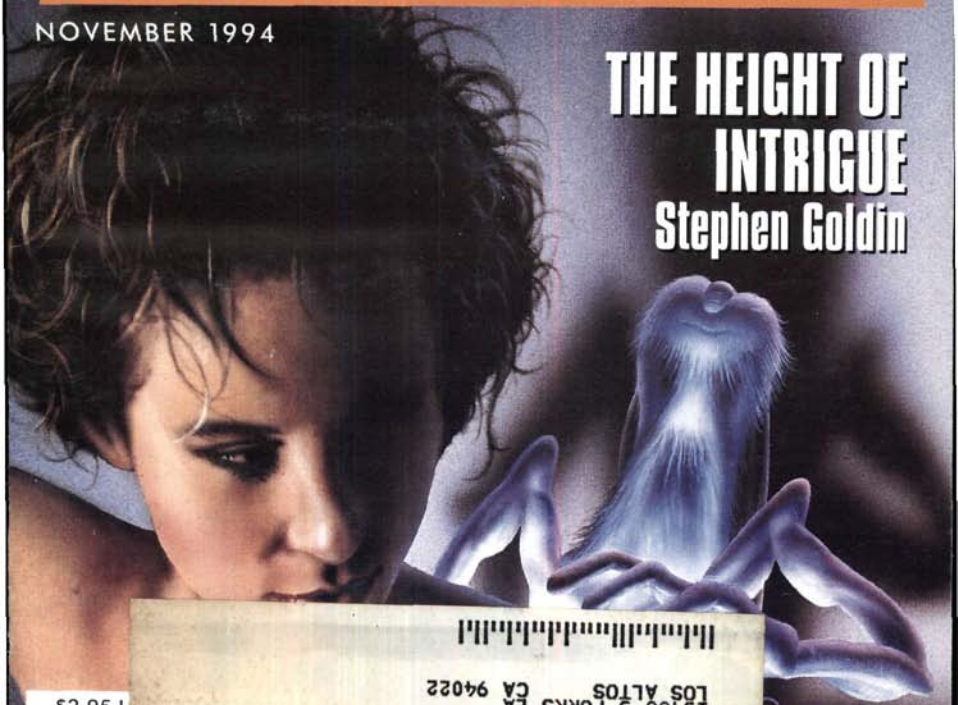

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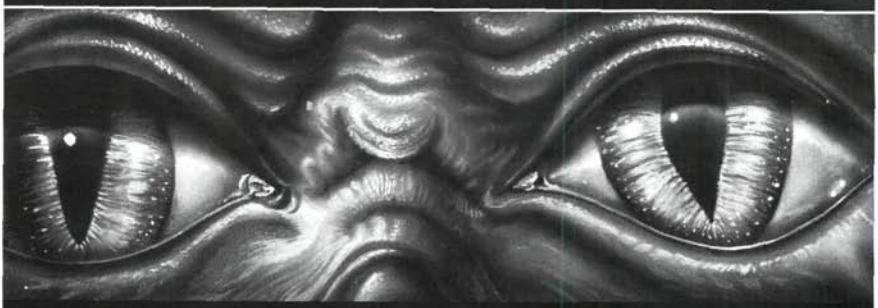

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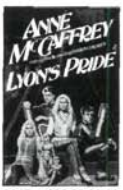

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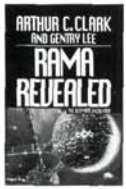

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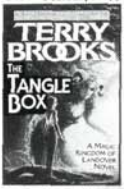

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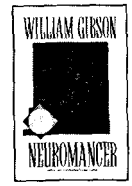

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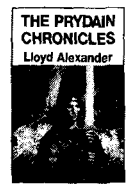

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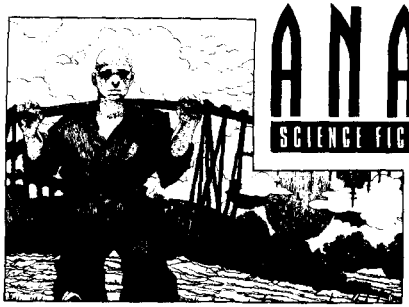

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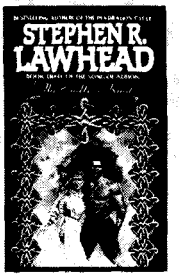

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EDITORIAL Stanley Schmidt

STATISTICS ABUSE

"How many manuscripts," asked the young man in the panel audience at a convention, "do you get in a typical month?"

"Maybe four or five hundred," I answered immediately, since I had heard the question many times before.

"And you publish maybe five or six," observed the young man. "So my chances of selling you a story are maybe 1 in 75 or so."

"Not at all," another panelist broke in before I could answer. "It's *not a lottery!* If you know how to write and know the market, your chances are much better than that. If you don't, they're much worse."

My fellow panelist—an experienced and successful writer who sells at least close to everything he writes—made a valid, important, and often overlooked point. The whole exchange is a good illustration of a common failing of our culture: a tendency to place great stock in figures, especially "odds," with little or no understanding of what, if anything, they actually mean.

The young man's statistics do have a *little* connection with reality, of course, though not a particularly *useful* connection. If you try to guess which manuscripts in my slushpile I will buy, without reading them or knowing anything about my selection criteria, the chances really are about 1 in 75 that any one you pull out of the pile will be one that I buy. (The *precise* meaning is a little more complicated than that, but beyond the scope of this diatribe.)

And that's not, of course, anything like the way I decide the *actual* fate of any particular manuscript. I do that by *reading* each manuscript and deciding by careful consideration of its individual characteristics how I think it would fit into a forthcoming issue of *Analog*. If you were sufficiently familiar with my tastes and quirks and what I'm trying to do with the magazine, you could read any manuscript and come up with a much better estimate than "1 in 75" of its chances of being bought.

In many cases your individualized estimate would be very close to 1:

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if I think a story is perfect for the magazine I edit, I *will* buy it if I possibly can. (It will seldom be an *absolute* certainty; sometimes I must turn down a story I like very much because I just bought one that's too similar, or because of a conflict with a book publication already scheduled.) In many cases your individualized estimate would be very close to zero, because some stories are so far from our needs that it's virtually inconceivable that I would buy them. Some simply aren't well enough done; others may be just right for some other magazine, but not this one.

Statistics like "1 in 75" are a way of making *some* sort of a guess when you don't know enough about the individual members of a group to predict what will happen to them. If you *do* have such knowledge, you'll do far better to use it—assuming that the detailed behavior of individuals is what you're really interested in, and that you have time to look that closely at individuals.

Sometimes, of course, you aren't or you don't. I use "odds" on manuscripts myself, in one highly specialized way. I do some of my manuscript reading on the train to and from my office in the city. For that purpose, I divide submissions into two piles: the "pros" and "slush." The "pro pile" is manuscripts which I have reason to believe are likely to capture my attention enough to require a very close reading, and perhaps a difficult decision as to whether to buy or not to buy. This might be because the author has had a high batting average in the past, or because I've already started reading a particular story and gotten interested enough to want to read it closely. "Slush" is everything else: stories about which I have no basis for estimating their likelihood of being right for *Analog*.

Please note carefully: this does *not* mean that the stories in either pile receive favored or "anti-favored" treatment. Every story gets read. Sometimes a complete unknown from the slush pile knocks my socks off and gets bought; sometimes an old pro sends me something that I can tell very quickly is not at all what I'm looking for. But statistically, I know that it's almost certainly going to take a lot longer to make decisions about all the manuscripts in a ten-centimeter pile of pro scripts than in a ten-centimeter pile of slush. Therefore I only read "pro" scripts on the train —because a slushpile I could com-

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fortably carry might not keep me busy for the limited duration of a ride.

That's one of the most important uses of statistics: to make valid statements about the *collective* behavior of large aggregates of individuals when you don't know much about the individuals as such. It shines in the branch of physics called statistical mechanics, where you can calculate the macroscopic behavior of a gas, which consists of an *enormous* number of molecules darting hither and yon, without knowing anything about the detailed behavior of even one of those molecules.

But doing such calculations, and interpreting the results, requires a kind of rigor that is too often lacking in statistical arguments by laymen and popular news media—a fact long ago recognized in the title of the book *How to Lie with Statistics*. People who really understand statistics define their assumptions, and the significance of results derived from them, in very precise terms. Most ordinary mortals don't—and if you bandy statistical terminology about in a sloppy fashion, you can "prove" nearly anything. The trouble is that if information is presented in a way that looks numerical, people take it more seriously than it deserves.

I don't intend to give a formal lesson on statistics, but thought you might be amused and have your thoughts suitably provoked by some actual examples. The one that caught my eye some months ago, inspiring me to plant the seed of this essay on my hard disk, was a full-page ad in a

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local news magazine, from an organization campaigning to prevent the construction of a sludge treatment plant in a particular location. "As promised in our last ad," the headline trumpeted, "a detailed list of the pollutants that will be produced by Plant X." It proceeded to list 31 chemicals or classes of chemicals, each with an "Emission Rate" such as "5.47E – 03." Then it said, "[The builder] claims that most of these emissions levels are safe—you decide!"

Sounds objective and fair as all git-out, doesn't it? Except that it gives *absolutely no basis* for deciding. In the first place, there are no *units* on any of its numbers, and therefore no way of knowing what, if anything, they actually mean. In the second place, there is no listing of what levels are considered "safe," and by whom and why, and therefore no way of evaluating the listed numbers even if you knew what they actually were! So the ad challenges readers to "decide for themselves," but gives them no information suitable for doing so. All the average reader is going to see is a long, intimidating list of unfamiliar chemical names and numbers in an unfamiliar notation. It won't even occur to him to ask what, if anything, those numbers *mean*. The sheer length of the list, and its frighteningly "scientific" appearance, are quite enough to make him decide, "We've got to keep that thing out of here!"

Which is, of course, exactly what the advertiser was counting on. (In case you're wondering, I opposed the construction of the plant myself, for reasons of my own—but I was not pleased to see somebody on "my side" using such shabby tactics to fight it.)

More recently I saw a review of a book called *What the Odds Are*, which incorporated several examples of "odds" taken from the book. To be perfectly fair, I should mention that I haven't seen the book itself, so I don't know how accurately the review represents what it says. But I do know that the review very explicitly says, "What are the odds you'll be murdered this year? One in 12,000." That *may* be true (I haven't checked) if you consider yourself as a random sample of a suitably defined population. But you could certainly define populations in other (and more meaningful) ways, and conclude that your *individual* chance of being murdered was much higher or much lower, depending on where and how you live.

It's similarly true that about 1 in 100 income tax returns is audited —but it's also true that you're much more likely to be audited if your return shows certain peculiarities than if it doesn't. So it is, at best, a gross oversimplification to say flatly, "The odds that you'll be audited this year are 1 in 100." Your odds of ending up in jail (for any reason) are much less than "1 in 200" if you scrupulously obey all laws, and much more if you go around assaulting policemen in front of witnesses. I'm not sure what "the odds of sinking a hole-in-one are 1 in 3,708" is supposed to mean, but I felt reasonably sure that Arnold Palmer's chances were a good deal better, while those of a non-

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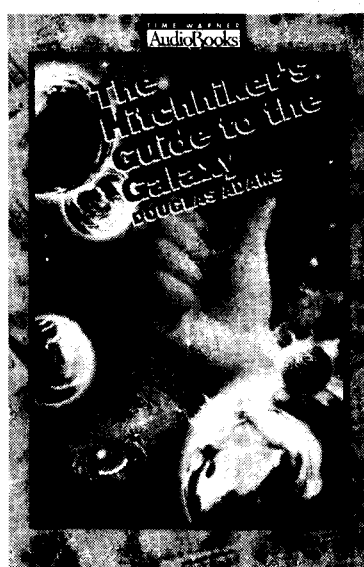

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golfer like me would be much worse.

In other words, practically every example of "odds" in the review is essentially meaningless, unless the underlying assumptions are explicitly stated. But it *sounds* "scientific," without actually requiring any thought, so I suspect the book sold well.

My good friend and esteemed colleague Rowland Shew showed me a newspaper clipping about which he commented, "Unusual for a news item, it includes sufficient data to comment on. To wit: the dichotomy between the headline and the lead sentence versus the actual data. The stacked deck nature of the sample . . ." The headline reads, "Greenpeace warns of warming disaster"; the lead sentence, "Many scientists believe that global warming is running out of control and could lead to total ecological collapse, Greenpeace said." But the *data* say that "Many scientists" means 113 who responded to a survey sent to 400 scientists "including those on the Intergovernmental Panel on Climate Change and others who have written on the issue in respected journals." So not even the sample to whom questionnaires were *sent* was anything like a random sample of scientists who might have informed opinions on the subject, and 72% of those who *got* the questionnaire did not see fit to bother returning it. You can't assume that those 72% had the same opinions as the 28% who did respond.

There's very little reason to consider such a twice-skewed sample representative of "many scientists." I note also that the news article does not give the actual wording of any of the questions the scientists were asked. I find it hard to believe that many self-respecting scientists would take seriously a questionnaire that asked in so many words, "Do you believe that global warming is running out of control and could lead to total ecological collapse?"

Mr. Shew is also fond of pointing out some interesting statistics in regard to Japan, often maligned for its "closed-market" dealings with the U.S. Ironic, since the actual export totals for 1990 showed Japan buying more from the U.S. than any other country except Canada (and more than Mexico and the U.K. combined). Furthermore, while Japan only bought $48.6 billion worth of goods from the U.S. that year, and the U.S. bought $89.6 billion worth of Japanese goods, remember that there were only 123 million Japanese, but 260 million Americans. *Per capita*, Americans only bought $344 worth of Japanese goods, while Japanese bought $395 worth of American. What was that about a closed market?

I'm running out of space, so I can only briefly mention a few of the other items Mr. Shew (who makes much of his living with statistics) has collected. There is, for example, the refutation of the popular truism that half of American marriages end in divorce—obtained by comparing the numbers of marriages and divorces per year. But that's a meaningless comparison, because most of those divorces are breakups of marriages that occurred in *earlier* years, many of which are still hanging in there.

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A more careful analysis suggests that only 1 in *8* marriages eventually falls apart (though even that is meaningful only in terms of specified ground rules).

Sometimes it's not even a question of "odds," but simply printing blatantly wrong numbers that haven't been checked for internal consistency. Probably most of these go undetected by most readers. How many readers would notice, for example, that a news story reporting that "New Jersey generates approximately 148 million tons of tires a year, about one percent of its total waste stream" implies that the average inhabitant (man, woman, or child) tosses out more than 18 tons of tires a year? As Mr. Shew observes, "Even allowing for corporate truck fleets, this seems excessive." We leave it to you to calculate the implications if it's true, as someone once claimed, that there are 3 million homeless persons in the U.S. and 45 of them die every minute.

Just one more item, hot off the presses: a recent *New Republic* article on the spotted owl scare claims that the original estimates of alarmingly low populations were obtained by counting owls in a small area and multiplying, while more recent surveys have spotted (no pun intended) numerous breeding pairs. It's small wonder they were missed if that's really how the original census was done. That's what statisticians call "faulty sampling"—you can't assume that all chunks of woods that look similar are really equivalent. When I heard this report, I was immediately reminded of an analogous set of results I could get for the Serengeti Plain, which is estimated to have about 1.5 million wildebeest. Wildebeest are herd animals, and migratory. Most of them stick fairly close together and move around a rough circle during a year, following the availability of food and water. If I had tried to estimate the total number by counting the population on *1/n* of the Serengeti and then multiplying by *n*, I could have gotten any answer from "wildebeest are extinct" to "billions and billions," depending on which acres I chose to examine.

I could go on and on, but it's really not necessary. Now that you see what you're looking for, I'm sure you'll have no trouble finding plenty more examples of "statistics abuse" in your own information sources. And if you complain about some of them, maybe—just maybe—we'll eventually see some improvement.

Statistics are an extremely useful tool for understanding events and making decisions—but only if you understand what they actually mean.

And what they don't. ■

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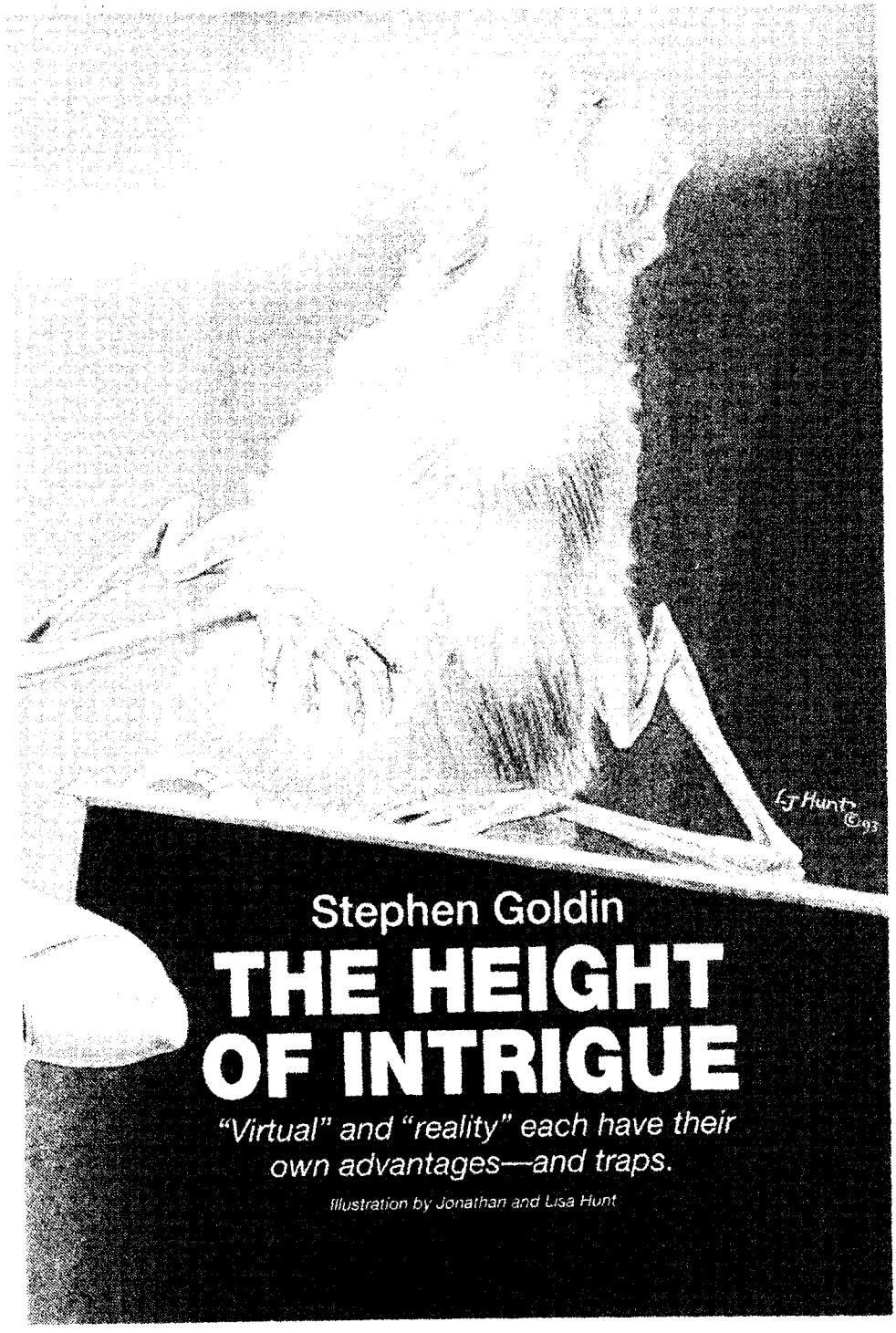

Stephen Goldin

THE HEIGHT OF INTRIGUE

"Virtual" and "reality" each have their own advantages—and traps.

Illustration by Jonathan and Lisa Hunt

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Rabinowitz didn't even open her eyes when the phone chimed. "Someone is damned impolite," she muttered, then said more loudly, "Phone: sound only. Hello?"

An unfamiliar male voice said, "Is this Ms. Debra Rabinowitz?"

"De-bor'-ah," she said instinctively. "The late Deborah Rabinowitz. Is there something the matter, Inspector?"

There was a pause. "How did you know . . . oh, because I sliced through your p-code. Very sly, ma'am."

"Compliments to be delivered only at the servants' entrance. I hope this call is worth overriding an ordinary taxpayer's privacy code."

"Well, I believe it is, ma'am. Would you mind if I dropped by your house?"

"Physically?"

"In person, yes, that's what I was thinking."

"Call back in twelve hours. I'm sure the corpse will have risen by then."

"I had in mind more like five minutes. I'm just now crossing the Bay."

"Five minutes? Do you have a warrant?"

"Well, you see, I was hoping to avoid an adversarial relationship at this stage of the process." He paused. "Will I *need* a warrant?"

"Five minutes," Rabinowitz sighed. "Phone: off."

She rubbed her eyes to force them open, then turned her head to look at the clock: 2:14 P.M. Not an unreasonable time for people who kept to local Earth hours. "The zombie stirs," she said with another sigh as she rolled her protesting body out of the water bed.

She staggered naked to the bathroom, peed, then ran a brush through her mercifully short brown hair. She looked at the makeup case and cringed. "No makeup. Zombies don't wear makeup; against union rules."

More staggering back to the bedroom. She opened the closet door. She stared blankly into the closet for three minutes without moving. The doorbell rang.

"Punctuality. The hobgoblin of little minds. No, that's consistency. Intercom: sound only, front door. Just a minute. I'll be right with you. Intercom: off."

She grabbed a demure yellow-and-white sun frock and slipped it over her otherwise naked body. Almost nude, she descended the staircase leaning heavily on the banister and muttering. "Here's a knocking indeed! If a man were porter of hell gate, he should have old turning the key." By the time she reached the bottom she presented a fair imitation of consciousness.

She opened the door to confront an excessively neat man in an expensively tailored suit. He might have been in his early thirties, but it was hard to tell with Orientals. Despite the afternoon breeze, not a hair on his head was out of place.

"Ms. Rabinowitz?" he asked, looking her over with a very appreciative glance.

"Yes. That establishes one of our identities."

"Sorry ma'am. I'm Detective William Hoy. May I come in?"

"Would it be déclassé to insist on

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some formal identification first?"

"Not at all. It was bad manners for me not to offer it in the first place." His hand slipped with one natural motion into his jacket's inner pocket and emerged with an ID card and badge. Rabinowitz had to squint to read it in the bright afternoon sun.

"Interpol?" She raised an eyebow in curiosity.

"That's right, ma'am. May I come in?"

"Only if you promise not to call me 'ma'am' anymore. I feel ancient enough this mor . . . afternoon."

"Fair game." Detective Hoy stepped inside. "I would very much like to thank you for seeing me on such short notice."

"You gave the subtle impression I had little choice. Follow me, please. I hope you'll excuse the state of things. People seldom visit me in person."

"I'm not from *House Glamorous.* Though your house *is* pretty trumpy from the outside."

"Thank you. It's well over two hundred years old. The elite of Victorian San Francisco liked to build their summer homes here on Alameda."

She led him into the parlor and offered him a seat. He sat in the left easy chair while she took her position behind the broad antique desk. The desktop, at least, was not too badly cluttered.

He stared appreciatively at the shelves around him. "I don't think I've ever seen this many printed books together in one place."

"Call it an affectation. Listen, ordinarily I'm great at small talk, but fatigue makes me uncharacteristically impatient. I've had just two hours' sleep after veering all over the Galaxy for the previous thirty-six. You didn't come here to discuss my house or my library. Neither one is Interpol's business. Please tell me what you're here for."

Hoy smiled. "And they said you'd be difficult. 'She's a diplomat's daughter, full of evasions and half-truths.' I like a person who speaks her mind."

"I'll speak a lot more of it if you don't get to the point."

"According to the phone company, you've done a lot of veering to the planet Jenithar in the past four months. Particularly to the office of Path-Reynik Levexitor." He shook his head. "Boy, that sure is a mouthful."

He looked at Rabinowitz. "Well, that *is* true, isn't it?"

"Statesman, yet friend to truth. Far be it for me to dispute the veracity of the phone company. Levexitor and I have been negotiating a multi-party deal for book rights on Jenithar. All perfectly legitimate, I might add. Levexitor is a high-ranking citizen of his world."

"High-ranking citizens have slipped before," Hoy pointed out.

"That is as may be," Rabinowitz said. "*My* dealings with him have been honest ones."

"You only sell works under copyright?"

"Primarily. I enjoy being my own boss, not a UN employee. I've occasionally mediated some deals for the WLO—"

"Your patriotic duty, of course."

"For a commission—but Earth benefited from each of the deals."

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"Then you don't like literary pirates?"

"Are you asking me or telling me?"

"Please humor me, Ms. Rabinowitz."

"The answer is no. Art and ideas are our only currency in interstellar markets. I'd be cutting my own throat to undermine that."

"That sounds like a highly practical form of patriotism."

"Oh, I'm sorry, you must have been looking for Deborah Rabinowitz the Idealist. She lives about twelve hours' sleep from here. I'll let her know you stopped by."

Hoy laughed. It was a good laugh, without guile. "You're fun, you know that? I'm glad I made the trip out here."

"Then that makes one of us. My 'practical patriotism' is wearing a little thin and I'm not having any fun at all."

"I'll get right to the point then. I have reason to believe your friend Levexitor is trying to buy some world domain material through the black market."

Rabinowitz leaned forward. "Wouldn't that put the matter in IPC's jurisdiction rather than Interpol's?"

"Well, after the fact, yes. We're trying to keep it from getting that far."

"Keep it all in the UN family," Rabinowitz suggested.

"Something like that," Hoy agreed cheerfully. "Have you ever had to deal with the IPC?"

Rabinowitz grimaced. "A couple of times."

"Then you know." He got up from his chair and started perusing the bookshelves. "Say, I think I had to read some of these in school."

"Am I officially considered a suspect, detective?"

He turned around and looked at her. "Oh, I hate to use the word 'suspect' this early in the case. It gives people the wrong idea." He looked back at the bookcase thoughtfully, then took one book from its spot and replaced it two titles to the right. "Sorry, that one was out of order. Knocks the hell out of me. You *are* arranging these alphabetically, aren't you?"

"Thank you. Feel free to come dust them sometime. If I'm not a suspect—"

"Let's just say you're someone I really wanted to meet and talk to. I'm not disappointed, either. You're as beautiful as you are charming. More beautiful than your file picture, even."

"My day is complete. Now if you'll—"

"Some people can be such a letdown, you know? You think they should be fascinating and they bore you to tears. But not you. You—"

Rabinowitz stood up behind her desk. "If you have no further questions—"

Hoy refused to take the hint. "Well, one or two. Was anyone else from Earth involved in your deal with Levexitor?"

Rabinowitz sat down again. "No. I was brokering on behalf of the Adler Agency, but I was the only one representing human interests on this deal."

Hoy nodded. "Did Levexitor mention any other names, human con-

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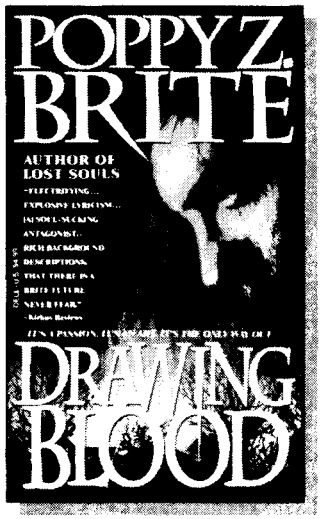

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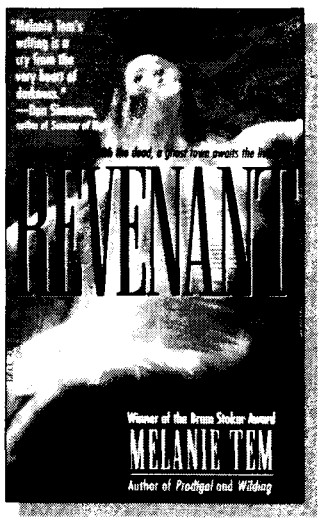

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tacts?"

"Not that I recall."

"Any other deals he was working on?"

"No, why should he? I'm not his partner. I didn't tell him about any other deals I'm working on, either."

"I understand. Well, that's about all I had for now." Hoy stood up and smiled at her. "It was great meeting you, Ms. Rabinowitz. A distinct pleasure. If you remember anything else, you can reach me through the local office, just across the Bay."

Rabinowitz rose from her chair to show him out. "Of course, if you turn out to be involved in the black market sale," Hoy continued, "rest assured I'll put you inside for a long time. But if you're not the one I'm looking for, would you have dinner with me sometime? After the case is solved, of course."

"Sorry, I never eat," she said as she closed the door behind him.

As the door closed she turned around, slumped against it, closed her eyes and sighed, "So pestered with a popinjay." The next thing she knew she was jerking awake as her chin hit her chest. She straightened up and deliberately opened her eyes wide. Directly in front of her was the staircase leading up to the bedroom. Beside the staircase, the hall extended to the kitchen at the back of the house. Hoy's comments about dinner had aroused her stomach's interest. "I need the sleep more," she mumbled, "but there's all those stairs."

She walked slowly to the kitchen, sure that if she moved too fast she would tumble and fall asleep before she hit the floor. She found two starchy slabs that were very probably bread, placed some unidentifiable filler between them and wolfed the conglomeration down before she could examine it too closely. Unfortunately, while this filled her stomach it left her feeling too wide awake to sleep. And there was a trap waiting before she could get back to the stairs.

She stopped beside the open veering room door. She looked inside. "I'll regret this tomorrow," she muttered. "Hell, I regret it right now." So saying she stepped inside. "Veering: Jenithar, office of Path-Reynik Levexitor.

"With any luck," she added to herself, "he won't be in."

She found herself in a vestibule in veer-space just outside Levexitor's office. She faced two large wooden doors bare of any ornamentation. The very fact that she was here meant his veering unit was turned on and her arrival had been announced to him.

"Ms. Rabinowitz," Levexitor's disembodied voice said. "That you should visit again so soon is unexpected."

"If I'm intruding, Highest, I beg forgiveness. I can return at another time."

There was a strangely long pause before he replied. "I see no reason why we should not discuss matters now. It is not as though I were busy with anything else. You may enter."

Rabinowitz stepped toward the virtual door in front of her. It swung inward to admit her to the reality Levexitor chose to show his visitors.

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Some people were creatures of fancy, creating elaborate virtual habitats of exotic design. The Jenitharp were not among these people. Levexitor's office looked exactly as it had every time she'd come here over the past four months. The walls were maroon with flecks of gold, while the floor was slick and slate gray. There were two doors—the one she'd entered and one at the other end of the room—and no windows. Light diffused from unspecific sources. The room was small; someone that important on Earth would have had a spacious office. It was a somber, cheerless room, almost like a barely furnished cave—but then, Levexitor himself was scarcely Mr. Personality.

Against the back wall was a low workbench where Levexitor's assistant, Chalnas, normally stood. Chalnas was a clerk of some kind who spent his time scribbling in a pad. Rabinowitz could not remember him ever uttering five consecutive words, and even that was merely to ask clarification of some point. Chalnas was not standing there now. He was one of those people you scarcely noticed when he was there, but his absence felt odd.

In the center of the room, at his own work desk, stood Path-Reynik Levexitor. The Jenitharp were bipedal, but humanoid only by a liberal definition of the term. They were shaggy cylinders, covered with a plumage roughly akin to marabou. Their two very long arms connected to the body at what should have been the waist; they could reach the tops of the slightly bulbous heads and the soles of their broad feet with equal ease. Their eyes were better hidden than a sheepdog's, and their voices seemed to resonate from their entire body.

Levexitor's veer-space projection was very tall, fully a head taller than Rabinowitz. His marabou was tinged with lavender, far more elegant than Chalnas's plebeian brown. He was so noble he scarcely needed to move.

There were no chairs in the room. Rabinowitz stood, Levexitor stood, Chalnas—when he was there—stood. The act of deliberately making oneself shorter in front of others was obviously unspeakable on Jenithar. If Rabinowtiz had not been able to sit comfortably in her lounger at home while "standing" in Levexitor's veer-space, some of her long negotiating sessions might not have gone as well as they did.

"Welcome, Ms. Rabinowitz. I had not expected to stand with you so soon again."

"I do deeply apologize for the intrusion, Highest. There were still a few minuscule details left to settle, and I thought we could lay them to rest once and for all . . . but if Chalnas is not here to record them—"

"It is Chalnas's day of relaxation, but I can remember well enough what we say. Please continue."

Rabinowitz spent the next ten minutes discussing the precise definitions of underwater theatrical rights to the three Tenger novels and the exact duration of the options. While this was a meaningless exercise, it gave her a legitimate excuse to be here.

There were uncharacteristically

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long pauses in Levexitor's responses, and he seemed more ill at ease. There was obviously some task in his real space that was preoccupying at least part of his mind. When Rabinowitz commented that he might prefer to deal with local matters and get back to her later he dismissed that out of hand and continued the discussion.

When they'd nailed the subject to the wall more thoroughly than it ever needed to be, Rabinowitz said, "Highest, I hesitate to bring up such delicate matters in front of someone so tall, but something has disturbed me so much I feel I must speak to you about it."

"Please feel free to speak openly," Levexitor said.

"Very well, Highest," Rabinowitz said. "I've heard rumors on Earth that criminal elements are trying to smuggle some of our literature to outworld markets. I've heard no names, but only the lowliest of our people would stoop to such activity."

"It is curious that you should mention such a subject just now, Ms. Rabinowitz. Please continue."

"I know that you, of course, are above such things. As a friend, though, I worried that you might, however unwittingly, be deceived by these clever criminals into performing acts that would certainly diminish you. I thought also you might know how to spread the word to your shorter colleagues, some of whom might yield to the great temptation. These criminals are unscrupulous, and would diminish anyone they dealt with."

"Indeed," Levexitor said. "I can understand only too well how someone, even the tallest among us, could momentarily be tempted by such offers, especially coming from tall sources." There was another long pause. "Yes," he finally continued, "and I can also understand the ultimate diminution you mentioned. To speak plainly, Ms. Rabinowitz—"

Levexitor stopped abruptly and turned. His head bent back as he looked upward. Then, uttering a small cry, he leaned forward against his work table and was very, very still.

"Highest? Highest?" The room was utterly quiet. Nothing moved, nothing made a noise. Rabinowitz glanced around. There was no one in the virtual room but Levexitor and her. And Levexitor wasn't moving.

Rabinowitz stepped forward until she was right beside the large alien. She reached out to touch him. There was solidity, like touching a tree while wearing thick rubber gloves, but no more sensation than that. Levexitor's projected body was as real as the walls—and no more animated.

She walked slowly around the room. Her footsteps made no sound. Levexitor made no sound. The only thing she heard was her own pulse flowing through her ears and the breathing she was trying to keep regulated.

It would do no good to call out to ask whether anyone was there. In *this* virtual space there was only her projection and Levexitor's projection. Someone or something may have intruded in Levexitor's real space, and might in fact still be there, but she could not see it.

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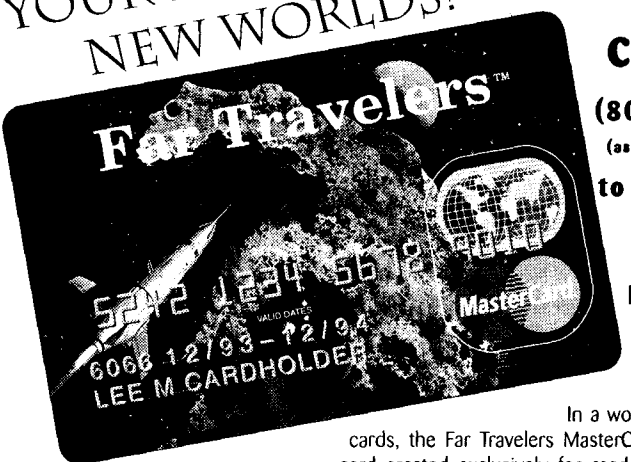

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Someone should be notified. She looked around the sparsely furnished room for some communications device. There did not seem to be any. Chalnas's work desk was bare and featureless. There were some digital controls on Levexitor's table, but he was sprawled across them and she couldn't move him. Even if she could, the controls would not have been intuitive.

Levexitor's body jerked back from the table suddenly. It was not a consciously controlled motion. As Rabinowitz watched, unseen hands played across the control panel on the desktop. Then the alien office suddenly blinked out of existence and she found herself back in her own veering room.

She wrapped her arms tightly around herself and sat down on the lounger, trembling like a leaf. Her teeth actually chattered; she couldn't remember doing that since she first read "The Telltale Heart" at age fourteen. She closed her eyes and tried to regulate her sudden gasps for breath.

Slowly, very slowly, she regained control. She forced her trembling lips to say, "Phone: San Francisco, Interpol, Detective Hoy." In moments the detective's smiling face appeared before her.

"What a pleasant surprise, Ms. Rabinowitz," he said. "I didn't think I'd hear from you this soon."

"Not pleasant," she said. "Not at all. You'll need to contact the authorities on Jenithar. Something just happened to Levexitor. I think he was murdered."

* * *

"I feel like such an idiot," Rabinowitz said. "I panicked like a dippy teenager. I was in no danger. He couldn't have touched me—"

"You were present when someone's life ended violently," Hoy said comfortingly from across the parlor desk. "Or at least, telepresent. I think it would be unnatural if you weren't in shock."

"He was right there with me," Rabinowitz continued. "The murderer. I couldn't see him, I couldn't hear him, I couldn't touch him. But he was there all the same. He was in the real world and I was in a virtual one, but we had a common link—Levexitor. Do you think he saw me?"

Hoy paused. "Well, he might have monitored Levexitor's computer without being in the space himself. Is your projected image true to life?"

"Basically. I'm pretty satisfied with the way I look."

"Then that makes two of us." Hoy gave her a broad smile.

"Thank you, detective. Every time I think you might not be a total grit, you politely disabuse me. I guess it doesn't matter whether he saw me or not. Levexitor mentioned my name often enough. The killer must have been there all along. That explains Levexitor's weird pauses. At least this means I'm off your suspect list."

"Well, I'm sorry to disappoint you, but no. You could have killed Levexitor yourself to cover your tracks once you knew I was getting suspicious."

"You have a truly paranoid mind."

"It's a living. You've moved further *down* on the list, though."

"Thank you." Rabinowitz looked

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him straight in the eyes. "Who else is on that list? What kind of company am I keeping?"

"You needn't worry your pretty little head about it."

"If one of your suspects killed Levexitor and if he knows who I am, he may try to silence me. I have to protect myself. I'm still a witness, even if I didn't see anything."

Hoy was thoughtful. "Well, if you are guilty this won't be any huge surprise to you. Jivin Rashtapurdi is definitely in the scheme somewhere."

"The gangster?"

"No, the grocer. And we're looking at another broker named Peter Whitefish. Know him?"

"I've had some dealings with him."

"And your opinion of him?"

"He represents his clients in ways he feels are best for their interests."

"Meaning?"

"Meaning there's such a thing as professional courtesy. Anyone else on the list?"

"There are some things *I* don't choose to tell, either."

"It's a short list."

"Women always say it's the quality that counts, not the length."

"We only do that out of pity. Any names on the outworld side?"

"I don't investigate the outworld side, just ours. I'm Interpol, not IPC, remember?"

Rabinowitz stood up. "Well, it was nice of you to come over and hold my hand during my little panic attack—"

"I wish I really had held your hand. It might have been fun."

"—But I really have had only two hours' sleep in the past forty-two. My cranky-alarm goes off in another seven minutes, and you don't want to be around when it does. Even my PMS-alarm pales by comparison."

"Then I'll try to catch you in a better mood sometime. The door's this way, right?"

"You're learning. That's a hopeful sign."

This time Rabinowitz got six hours' sleep before a police official called.

"I just want to rent a body," Rabinowitz said grumpily, "not get a bank loan."

"There are strict laws," the alien said. Jenitharp didn't shrug, but the gesture from his virtual image was one of helplessness in the face of bureaucracy. "If I were to mistakenly give you the wrong size body, I would lose my license. And my government has strict laws against letting convicted felons telepresent themselves to Jenithar. Please answer all the questions."

"Your police asked me to come. They want me to inspect a murder site."

"Then it's best to quickly complete this form."

"I'm glad I don't have to do *this* every time I visit Jenithar," Rabinowitz muttered. "Veering is so much more civilized."

She handed the clerk her standard bio datastar and checked to make sure the answers entered the proper fields. "Full name: Deborah Esther Rabinowitz. ID number: 5981-5523-5514-276-9467-171723. Date of birth: 17/46/3/22/54 interstellar. Education: first-level degree, University

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of California at Los Angeles, Interstellar Studies, second- and third-level degrees, Polycultural Institute on Pna'Fath, Galactic Commercial Standards and Crosscultural Dynamics. Progenitors: Daniel Isaac Rabinowitz and Barbara Samuelson Rabinowitz. Father still living, mother deceased. Progenitors' occupation(s): father, diplomat, plenipotentiary level, general assignment; mother, professor of comparative world literature, University of California at Los Angeles. Siblings: none. Offspring: none. Occupation: literary broker. Bank: Takashiro World Savings. Income—"

She paused. "This is kept confidential, I presume."

"Oh yes. We have strict laws against unauthorized disclosure."

She gave the information requested, about both her personal finances and her business's. But she balked when she read further into the questionnaire. "I'm not putting up with it. Look at this list. Does the subject have any criminal convictions; what was the subject's standing in school; what titles has the subject held; what awards have I won; who are my family members for two generations forward and back and out to third cousins; are any of *them* convicted felons, who are my business associates and clients, what are *their* status ratings . . . it just goes on and on. You ask everything except whether my clients molest their household pets. Check my father's *Who's Who* listing if you want to know about my family, but I'm not giving out information about my clients."

"I must calculate your exact rank so I will know what size body you should have. It only needs to be done once. After that your records always will be on file."

"Stand not upon the order of your going. I don't give a . . . look, just give me any size body you want. Or turn me down and I'll go to one of your competitors."

"I can probably correlate your data with enough other public information to get what I need," the rental clerk said. He stared blankly at his computer for several seconds, then continued, "I believe, possibly, I have sufficient data to analyze your height equivalent. Wait one moment while I match you to a suitable body."

Rabinowitz waited considerably longer than a moment. Then the clerk said, "All is ready. Prepare for joining."

No matter how often she did it—and she'd done it more often than most people on Earth—melding with an alien body was always disorienting. People of every planet constructed mechanical rent-a-bods as much like their own as possible, making them awkward for anyone who was shaped differently. Some races had more than two arms, and a human could only leave some of them dangling limply; some had fewer, and a human felt handicapped. Some saw in wavelengths incomprehensible to Earth people, while others heard in ranges humans couldn't make out.

Worst of all, though, were the ones that were *almost* humanoid, like the Jenitharp. They had two arms and two legs, but the arms came out at

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the waist, halfway down the body, in a strangely jointed arrangement that could by no means be called shoulders. The waldo hands were too far away from the head. It felt like she was living inside a funhouse mirror.

Rabinowitz found herself standing beside the clerk, looking down at him. "I've notified the police," he told her. "They will arrive shortly to escort you. They asked that you wait here."

"Fine. I prefer a little time alone with a new body so I can learn how to work it."

"If you wish it, now that we have your height on file, we can charter you a permanent body for a slight additional charge. A body would be permanently reserved for you and you could visit Jenithar whenever you wished without going through such inconvenience again."

"Thanks. I'll keep that in mind if I'm ever forced to do more business here."

The clerk departed, leaving her alone. The room was crowded with racks of rental bodies of all different height ranges—many smaller than hers, some considerably taller. Her body felt heavy. Many races built their visitors' bodies out of plastic or other lightweight materials. Some even grew them from living tissue. The Jenitharp made theirs of clanking, cumbersome metal. This body was covered with a fake greenish-brown marabou. Given her size and color, she was apparently of a decent ranking.

Rabinowitz hobbled to a clear area near the center of the room and started moving around. The leg motions weren't too bad if she took lots of tiny steps, as though she were wearing a very tight kimono. The long, thin arms felt useless and dangly; they seemed to flop about like rubber hoses, and she practically had to dislocate her own shoulders to move them. They were more tentacles than arms, no real joints to them. "You have to be a Balinese dancer to make these things move right," she muttered.

After fifteen minutes, she felt comfortable enough not to embarrass herself too badly. Fortunately, no one expected an alien in a rented body to be graceful. Every race had its own jokes about how clumsy alien visitors were.

A couple of newcomers entered the room, one somewhat taller and paler than the other. There was no immediate way to determine their genders. "Ms. Rabinowitz?" said the taller one, who was still shorter than she was. "Allow me to introduce myself. I am Feffeti rab Dellor, third level constable. I am grateful you've agreed to assist our investigations. If you kindly would accompany me, we shall visit the site of the murder." He did not bother to introduce his shorter companion.

"Lay on, MacDuff," Rabinowitz replied.

The constable paused. "I'm sorry. That failed to translate well."

"Never mind. It was a literary allusion. I shouldn't be giving those away for free, anyway."

Constable Dellor and his companion led Rabinowitz through a

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crowded hallway to an elevator, where they shoved into a large car with many other people. They descended sixteen floors before Dellor indicated they'd reached their level. They got out and walked through still more crowds to a public vehicle stop. The crowds parted for them as they walked; perhaps Dellor had some police insignia Rabinowitz couldn't recognize, or perhaps the people were being respectful of her height, which was greater than almost everyone else around her.

Apparently even the police took public transportation here. They claimed the very next cab in line, jumping ahead of everyone else waiting. Dellor gave the driver, who was considerably shorter, a police override code and a destination, and the cab sped off.

Rabinowitz's only previous experience on Jenithar was in Levexitor's veer-space, so her first "real" looks at it fascinated her. The sky was overcast, and even though her artificial body couldn't discern normal ranges of temperature or humidity the weather felt muggy. The sky was bright despite the clouds; Rabinowitz had read that Jenithar's sun was an F-class, slightly brighter than Earth's. Her rented body's filters cut down the light to manageable levels, but they did strange things to her depth perception and made colors seem washed out and unnatural.

This particular region was a city crammed with enough skyscrapers to make any Manhattanite feel comfortable, but that same New Yorker would have gaped open-mouthed at how clean it all was. Legions of municipal workers were employed solely to keep the buildings and streets immaculately scrubbed and litter-free. Rabinowitz might have thought this stemmed from some sense of civic pride if her previous reading hadn't explained it was part of a full-employment program.

There were people everywhere, constantly in motion. They formed long lines of pedestrians beside the streets, arranged in rows according to height, with each sidewalk dedicated to one-way foot traffic. There was a swirl of colors and shapes, but surprisingly little sound. Being forced to live so closely together, the Jenitharp developed strict rules about invading someone else's privacy with their own noises.

"You are a literary broker, this is correct?" Dellor asked as they rode along.

"Yes. Jenithar is still a wide-open market for my world's literature."

"Had you been long dealing with Highest Levexitor?"

"Just for the past four months," Rabinowitz replied. "I'd hoped it would be the start of a long business relationship, but now it looks like I'll have to make other contacts."

"You have stated that when he was killed you were visiting Levexitor."

"I was veering only. There were awkward silences in our conversation. I suspect someone else was physically present at the same time, but that person wasn't linked into the veer-space so I don't know who it was."

"About what subject were you

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speaking when the death occurred?"

Rabinowitz hesitated. "Business," she said. "I had come to talk about the underwater theatrical rights to the works we were negotiating—"

"There is no need to elaborate," Dellor interrupted. "I do not need to know the intimate details of the Highest's business affairs. Did you know Dahb Chalnas well?"

"Levexitor's assistant? Not really. He was usually there in the background when the Highest and I met, but he seldom even spoke."

"He was, though, not there this time."

"Not in the veer-space, no. Levexitor told me it was his day off."

The cab had reached a different part of the city, far less crowded. The buildings here were smaller and detached from one another, and eventually their vehicle pulled to a stop in front of a two-story house with a low wall around it and a postage-stamp garden in the front yard. Rabinowitz looked at it in wonderment, Levexitor was one of the most important people in Jenithar, and his house was less than two-thirds the size of her own. "Everything's relative," she muttered as she got out of the cab with her police escorts.

The constables led her into the house, and she stared with shock as she crossed the threshold. Levexitor's home made simple squalor look respectable. Piles of detritus covered the floor, making it hard to find a clean path to walk, and she had to step carefully over little rivulets of yellow-green fluid. Greasy globules of some unidentified viscous material oozed down the walls. Rabinowitz was sure the stench would have knocked her unconscious if her artificial body could have transmitted anything more in the way of smell than an alarm about smoke or corrosive chemicals.

"Who's his decorator?" she asked aloud. "Central Sewage and Reclamation?" This house was such a contrast, both to the cleanliness of the public streets and to the starkness of Levexitor's veer-space, it was hard to believe they belonged on the same planet. But she knew lots of people on Earth, too, who kept their veer-space looking very different from their real homes and offices.

"He must have had a very incompetent staff," she continued.

"Highest Levexitor lived here alone," Dellor said. "He had no staff except his clerk, Dahb Chalnas."

"All alone? No staff? A man as tall and important as Highest Levexitor?"

"One of the advantages of being so tall," the constable said, "is that you're *allowed* to live alone."

Rabinowitz nodded thoughtfully, or at least tried to; the action made her heavy metallic body bob unsteadily. "I guess so. Well, show me what you wanted me to see so I can get this body back to the agency. They'll want to give it a good acid bath before it's used again."

Dellor led her through several rooms, each more disgusting than the last, until finally he stopped and said, "This is where Highest Levexitor was murdered."

As far as Rabinowitz could see, the only resemblance this room bore to

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Levexitor's veer-space was the tall work table with the computerized desktop, an analog to the one he'd been standing at when he died. "This isn't really anything like what I saw."

"I didn't expect so. Just tell us what you *did* see."

"Highest Levexitor was standing at this table, talking to me. There were occasional pauses; he might have been pulling momentarily out of veer-space to talk to someone physically present. In the middle of our conversation he suddenly looked up, gave a small cry, and slumped against the table. I looked around, but couldn't see anyone else in the veer-space. Then the Highest's body jerked upright—I assume his murderer pulled his physical body up to get at the veering set—and I saw the controls being worked by invisible hands. Then the connection was broken and I was back in my own home."

Dellor was silent for a moment, then said, "This confirms our theory. Accept our gratitude for your cooperation. We will take you back to the rental agency now."

"Wait a minute. This is it? You go to the expense of bringing me here, make me go through all the rigmarole of renting this body, and take me to this festering sewer just so I can spend two minutes looking at a table and telling you the same story I did over the phone?"

"That is correct."

"Tell me, what is this theory of yours?"

"Really, that is not of your concern."

"Well, I'm making it my concern." She stood beside him and drew her body up to its full height, staring down at him with what she hoped was icy imperiousness. "And if you ever hope to be any taller, *you'll* make it my concern, too."

Dellor paused. "It is really too simple to bother you with. There is only one person who could have committed the crime."

"Humor me."

"It could only have been his assistant, Dahb Chalnas. We have already detained him, and it will be but a short while before he confesses."

"Right. The butler did it. How did you come to this startling revelation?"

"It is not difficult. Chalnas is the only person who had access to the house."

"Couldn't the Highest have let someone else in?"

"Like most people of his height, he valued his privacy too much. He wouldn't have let someone else in physically when he could simply have veered them."

"Unless there was something he didn't want to discuss over the channels," Rabinowitz mused.

Dellor paused. "Do you have evidence of such delicate matters?"

"No. No evidence. But why are you so convinced it's Chalnas? He always seemed so quiet, so meek."

"Ms. Rabinowitz, you are a stranger to Jenithar. You do not know our ways. People as lowly as Chalnas often harbor poisonous envies of their superiors. I have seen it happen far too often, a person killing someone taller than he for no apparent reason

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but frustration and rage. Perhaps it is a sad commentary on our civilization, but it is a fact we must live with."

"What did he hit him with?"

"I beg your pardon?"

"If Chalnas was that much smaller than Levexitor, his bare hands probably weren't strong enough to kill him. What did he use as a murder weapon?"

The constable was not the least bit phased. "He could easily have used some heavy object in the room and then taken it away to dispose of. As you see, it is impossible to tell whether anything is missing. Please believe me, Chalnas is undoubtedly the culprit."

"Well, if you're that sure . . . this is your business and your planet, and I have no right telling you how to run it. Next time, though, just talk with me on the phone and don't bring me teeping all over the galaxy just to look at slag heaps."

Rabinowitz tried hard to concentrate when she returned home. There was a rehearsal in just a couple of days. She had scenes to block out for Mac and Lady M. as they chewed on each other while plotting Duncan's fate. But other visions intruded. When she wasn't seeing the quagmire of Levexitor's home, she was thinking about quiet, servile Chalnas in prison for his boss's murder. The chiming of the phone was actually a blessed interruption—especially when she checked the caller ID before accepting the call.

"Nils," she said, smiling into the phone. "It's been—what, three years? Four?"

Nils Fredericksen, UN Secretary for Interstellar Commerce, smiled back at her. His blond hair had long ago evolved to gray, and his blue eyes twinkled out from a lean face as soft as well-oiled leather and as craggy as his native fjords. "Let's not embarrass either of us by putting a number to it. Let's just say it's been too long and leave it at that. How have you been, my little princess? I hear you've established quite a business for yourself."

"I'm happy with it. I've brokered works on over seventy different worlds already. Your Undersecretary for Literature can tell you I've done my share to fill Earth's coffers."

"I never doubted that for a second. I always knew you were the secret behind your father's success. How is he coping with his retirement, by the way?"

"Enjoying his condo in Tel Aviv, going down to the beach every day. As he put it, 'I have to beat off the women with a stick, and at my age the arm tires easily.' "

Frederickson laughed. "That's Daniel. He loved your mother so much I don't think any one woman will ever replace her."

"Speaking of replacing, I'm sorry about Chien's appointment. I know you were hoping for the top spot. You certainly earned it."

"Thank you. I wish the Assembly agreed with you. They probably see me as a dinosaur from a bygone era and want new directions."

"So what are your plans, Mr. Dinosaur?"

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"I just may decide to retire, myself."

"That's hard to imagine. You've been plugging away up there longer than I've been alive. I was always sure you'd die in harness."

"I almost did yesterday."

Rabinowitz sat up straighter. "What happened?"

"I had to attend a Dikwanic opera. Strictly in the line of duty, of course."

Rabinowitz laughed. "My God, talk about a fate worse than. I attended one in college—or tried to. It's bad enough you have to sit rigidly at attention for five hours; then they make you listen to music so atonal it drives Chinese crazy. That's more than humans should have to endure. Thank God I teeped to it; I could slip out of the rented body and come home to eat and use the bathroom." She paused. "And the Dikwano wonder why they can't sell the rights here on Earth."

"So you understand, then, why retirement looks more and more attractive."

"Well, you should certainly demand hazardous duty pay."

Fredericksen's face grew more serious. "I didn't come here to talk about my troubles, princess. I came to warn you."

"About what?"

"There is a very fanatical young Interpol detective named Hoy who may be bothering you—"

"Too late. He's already been here."

"I'm sorry. I'd hoped I could warn you in time. What did he talk about?"

"About a plot to sell some world domain properties on the black market."

"That doesn't surprise me. I've talked with his superiors. They tell me he's something of a loose cannon, always going on about some crackpot conspiracy theories. He just charges out and harasses people, with little or no evidence that any crime has even been committed. Maybe he thinks if he flusters enough people, some guilt will shake loose."

"Maybe something did shake loose," Rabinowitz muttered half to herself.

"Excuse me?"

"Did you know Path-Reynik Levexitor from Jenithar?"

"I know *of* him. I've been to Jenithar a lot the last year or so, and he's a very important personage there. In fact—" Fredericksen wrinkled his brow. "I saw his name in a report that crossed my desk this morning, but I haven't had a chance to read it yet."

"Let me save you the trouble. He's dead. I was talking to him in his veerspace when it happened."

"How horrible! Do the police have any idea who killed him?"

"They've arrested his clerk, but I don't know . . . it just doesn't feel right to me somehow."

"If there's one thing you should have learned by now, with all your diplomacy and all your studies, it's to stay out of alien legal problems. They have their own ways of doing things that always seem bizarre to us. If they're happy, let it go."

"I know. I'm being a good little girl, honest."

"I'd expect nothing less from you." His voice grew more somber. "You

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mentioned Levexitor in connection with Detective Hoy. Was there some link between them?"

"He thought Levexitor was playing a pivotal role in the black market deal, yes."

"There, you see, he loves to go after big names, important people, whether there's any merit in his charges or not. He's very clever at using innuendo. Be wary of him."

"After all those years helping my father, do you think I can be fooled by innuendo?"

"Not the Deborah I know. Did he mention any other names?"

"Another literary broker named Peter Whitefish, and some other man I've never met." She paused. "He didn't mention your name."

Fredericksen looked worried for a moment, then smiled. "You always were a shrewd young lady. Yes, he's been harassing me, too—and he *did* mention your name to me, which was why I was calling to warn you."

"Thanks for thinking of me, but I'm not a little girl any more. Unless Detective Hoy pulls his gun on me, I think I can handle him on my own."

"I know. But I still worry."

After Fredericksen signed off, Rabinowitz continued to stare at the blank screen. "Actually," she muttered, "what Detective Hoy really wants to pull on me isn't his gun." She smiled sardonically. "But I can handle that, too."

Rabinowitz spent most of the next day researching Jenithar's inheritance laws. She had a deal almost entirely nailed down with Levexitor; now that he was dead, where did that leave her and her client? Did someone else take over the account? Did she have to start from scratch with someone new? Did Levexitor's superior height mean no one could take his place, or would someone be elevated to fill the vacancy?

Late that afternoon she received a call from Jenithar. She half expected it to be the police again with more useless questions, but it turned out to be a stranger calling himself Raj-Pen Dewahl. "Ms. Rabinowitz, rumors of your fine stature have dazzled my senses," he said. "If to you it is acceptable, I would beg permission to veer to your office."

"Is this about the rights to the Tenger books?"

"It indeed is."

"Then this is a happy coincidence. By all means, veer in." Even as she spoke she was setting her controls to receive and entertain.

Her veer-space office was almost an exact duplicate of her parlor, complete to the books in the bookcases. She'd even gone to the trouble of loading the books into memory; the virtual books on the virtual shelves exactly matched their real-life counterparts. It was a small vanity, but she reveled in the detail.

Dewahl entered through the double doors. Rabinowitz's image was seated; this was her home ground, so she made the rules. She knew better than to offer her guest a seat, however. He could sit or stand, as he chose.

Dewahl chose to stand. He was not nearly as tall as Levexitor and his

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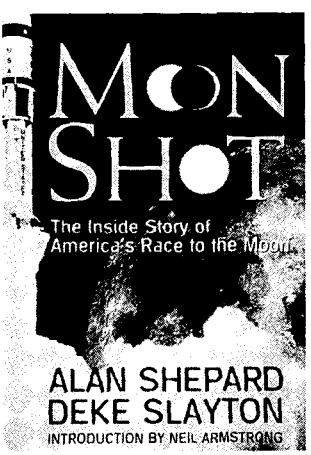

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plumage was still close to plebian brown, but he certainly had a thick coat of it. He was far more magnificently plumed than Levexitor had been.

"Highest Levexitor's untimely death brought to all of us a great sense of loss," he said. "However, it also brought to some an opportunity. While I by no means can match Highest Levexitor in stature, I am in a position to exercise the same rights for which he was negotiating."

"All three of the books by Maurice Tenger?"

"The very same. How perceptive of you."

"I presume your credentials are in order."

From somewhere under all that marabou, Dewahl produced a datastar and handed it to her. Rabinowitz slipped it into the receptacle and quickly scanned the readout. All the licenses from both Jenithar and Earth seemed current; she could check their authenticity later. She made a quick copy and handed the star back to him.

"The situation is highly mobile," he told her. "You may be contacted as well by others. I assure you, though, no one is better positioned to be more generous than am I."

"You don't know how glad I am to hear that." Rabinowitz went on to list the terms of her agreement with Levexitor, exaggerating each clause slightly in her favor. Dewahl never flinched.

"It sounds highly equitable," he said when she finished.

"Good. I'll have my attorney draw up some contracts. You should have them in a few days."

"Most excellent." He looked as though there was more on his mind that he didn't have the words to express.

"Was there something else?" she asked.

"These dealings have been so fortuitous, I was wondering whether other deals might be made as well."

"I'd love nothing better. I represent many different clients and agencies. What kind of work did you have in mind?"

Dewahl shimmied uneasily. His marabou shook in an oddly disquieting manner. "It is said that there are some works from your world lacking in contemporary representation."

"Sounds like an oxymoron to me. I can't represent work that isn't represented."

"Perhaps I misphrased myself. I meant work whose creators are no longer available to represent it."

"I think you mean world domain. I'm afraid I can't help you with that except to direct you to the proper United Nations office. By Earth law, I can only handle material that's still under copyright; the UN takes jurisdiction when it becomes world domain."

"Perhaps I was misinformed. One hears stories of deals being made outside of normal channels . . . it is so hard to know the truth when the only one who knows all is Dahb Chalnas, and he is scheduled to die in six days for his crime."

"So soon? I guess Jenitharp really believe that justice delayed is justice

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denied. Who told you I might deal in world domain material?"

Suddenly the room went red. Dewahl vanished, to be replaced by an image of dark circles inside brighter ones, images of her own eyes. They throbbed and pulsed, then slowly began to circle one another like mad moons. The room faded to navy blue, and a myriad of little stars began sparkling, closing in from the periphery. Her ears filled with a hypnotic humming, constant and yet also in tune with the throbbing eyes.

She could not feel herself. Her limbs, her body, her head—all were gone. Reality was just the blue and the stars and the moon-eyes, receding slowly into the distance like an escaping soap bubble, until it quietly popped and made nothingness out of nullity.

She squinted at the colors trying desperately to coalesce into shapes and she swatted instinctively at the swarm of flies that buzzed around her head. Very intelligent flies, obviously—the buzzing sounded almost like words. "You gave us quite a scare," the swarm said.

"You're not my Auntie Em," Rabinowitz mumbled hazily. She tried to roll over and go back to sleep, but bumped her shoulder on the side rails. The texture of her waterbed was all wrong, too, much too hard and firm.

"Don't zip out on me just yet," the flies said, but they were losing some of their buzz. "The doctor said you should stay up for awhile." Hands grabbed her and pulled her into a sitting posture. This had the unintended effect of causing the whole Universe to wobble. The colors shifted in and out of focus like a drunken kaleidoscope.

"Do you know who you are?" the flies went on.

"Of course I know," she said. "I know, therefore I am. I think."

"Ah, even if it wasn't in your files I could guess you were a college graduate. Do you know who I am?"

"The Lord of the Flies."

"Close enough for government. Now for the big one: Do you know where you are?"

"In bed," Rabinowitz said. "You can't fool me that easy."

"And they told me you wouldn't make any sense. Do you know who tried to kill you?"

"Kill me? Kill me?" Rabinowitz put her hands up to hold her head steady, which caused the colors and the flies to merge into the form and voice of Detective Hoy. "Did somebody try to kill me?"

"No fair, I asked you first."

"Nobody wants to kill me. I'm cute, I'm sweet, I'm bright as a new penny. My Daddy showed me a penny in a museum once, but there haven't been new ones for fifty years. Doesn't matter, it's the principle of the thing. Nobody would kill me. I'm beloved of all. By all. Whatever."

"Yeah, I'm sure you always wake up like this."

"Yes. No. I don't remember. It's a lady's prerogative not to remember."

"Maybe, but it's not a lady's prerogative to be found unconscious on her veering room floor."

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"Then, since I'm every inch a lady—however much an inch is—I won't do it."

"Oh yes, I quite agree. Once was enough."

Her mind was circling the idea like a hawk about to swoop. "Somebody tried to kill me?"

"I guess it must take some getting used to. Yes, somebody tried to kill you. Somebody with a lot of resources. How much do you remember?"

"You would ask a trick question. My memory is not plugged in today. The whole rest of the world is at the wrong end of the telescope, and I can only wave at it from the shore."

"Your veering set was still hooked up and running when they found you. Do you remember that much?"

"I don't remember going anywhere."

"Did somebody come to you?"

Rabinowitz started to nod slowly, then reached up quickly to grab her head as it threatened to fall off. "That sounds possible. All things are possible in time."

"According to phone company records, you got an incoming call from Jenithar."

"You have an annoying habit of asking questions you already know the answers to."

"I know *my* answers to them. I don't necessarily know yours. Besides, the phone company couldn't verify the party at the other end of the line."

"Jenithar. Yeah, someone from Jenithar. That sounds about right. I don't remember his name. It'll be in my log. I record all calls. Seemed to think I could get him some world domain material. Funny, huh?"

"Hilarious. What did you tell him?"

"Just the Bible, the Koran, and the complete works of Shakespeare." She let go of her head experimentally, and it seemed to stay precariously balanced atop her neck. "Somebody tried to kill me?"

"Is there an echo in here?"

"You said it was somebody with a lot of resources."

"For somebody whose memory isn't plugged in, you're doing a good job."

"Virtual memory, an effective simulation. Why did you say that about the resources?"

"As near as we can tell, this person tried to kill you with a sensory overload program. It's not real common here on Earth—we don't even tell people it's possible—but there are some twinkers from Besortix who specialize in it. Their program slices into your veering set on some other carrier wave so it can't be traced back to them. Once it's on your system it overloads your senses, particularly sight and sound. It tries to lock your brain into a weird pattern, like certain flashing lights can trigger an epileptic attack or a migraine. Only this program tries to make the condition permanent. If it burns in deep enough, it can even affect the brain functions that keep your heart and lungs working."

"That's insid . . . insid . . . wicked. How did I survive?"

"A Besortican wouldn't have. As I said, it isn't that common here yet

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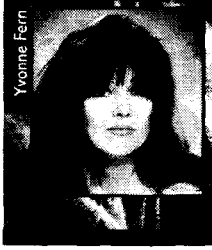

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and the Besorticans' AI algorithms for us were just that far off the mark. It just put you out. A lady named Francia Bowd called Emergency Services and said you'd missed a rehearsal of your play and she couldn't reach you. At that point we think you were in a coma for at least eight hours. I had a flag out on the nets for anything with your name, so I got to the hospital about the same time you did. Good thing, too—the doctors here had never seen this before."

Rabinowitz was quiet for a while, then said, "So what's the prog... prog... prog..."

She slammed her fist against the side rail in frustration. "Prognosis," she finally said. "Am I going to have mental malarial relapses? Facial tics? Will I attack anyone who mentions Niagara Falls?"

"The only permanent side effect we know about is death. You seemed to have avoided that. Oh, and none of the surviving victims has ever played the contrabassoon afterwards. Of course, our records on this only go back about seven years. We'll want to monitor you closely from now on."

"Does that mean I'm off your suspect list?"

Hoy smiled. "Not at all. A falling out between conspirators could make one try to down the other."

"Someone with resources, you said. Were you thinking of Jivin Rashta... Rashta... that grocer guy?"

"A distinct possibility. He's been unofficially linked to several previous Besortican-style attacks."

"So how can I protect myself in the future?"

"You could keep your veering set permanently turned off. Or you could let us monitor all your sessions."

"Neither appeals to me."

"Does death?"

"Did any of them play the contrabassoon *before* they were attacked?"

Hoy stood up and walked to the door. "You know, I really do hope you're innocent. You're a lot of fun in bed."

"Treasure the memory. It's the most you'll ever get." She turned over, facing away from him, and pretended to sleep. The pretending lasted less than two minutes.

Rabinowitz was not allowed to leave the hospital for another thirty-six hours, during which she was subjected to multiple brain scans, neurological examinations, and tests of both physical and mental coordination. It was almost as bad as renting her own body. When she could get through the tests without embarrassing herself, the doctors said she could go home.

She walked straight through the front door and down the hallway to the veering room. She stared at the set as though it were a puppy that had peed on her carpet. The room was not as she had left it; it must have been a mess while she was lying unconscious on the floor. "Probably Hoy," she muttered. "He straightens bookshelves. I wonder what else he did to the room while I was gone."

She ran her hand along the side of the veering set for a moment, then turned away from it to the ordinary telephone. She placed a call to Peter

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Whitefish, but only reached his recorded message. She left her name and number, asking him to phone back as soon as possible.

By calling in two different favors she got the direct number to the executive offices of Indra Entertainment. The secretary told her Mr. Rashtapurdi was unable to see anyone today; she could have an appointment in three weeks.

"Please tell him I know a few things about Path-Reynik Levexitor from Jenithar," Rabinowitz said.

The secretary put her on hold. Rabinowitz hummed to herself for thirty-seven seconds. When the screen woke again, she was facing Jivin Rashtapurdi.

Rashtapurdi was an older, dark-complected man whose white hair was in sharp contrast to his skin. He had a wide face and intelligent eyes. White teeth showed in the smile that seemed as wide as a barn door and as shallow as a sidewalk puddle two days after the last rain.

"My secretary tells me your name is Rabinowitz," he said. "What can I do for you?"

Rabinowitz looked at him appraisingly. "I'm a business associate of Path-Reynik Levexitor from Jenithar."

Rashtapurdi's smile never wavered. "Is that name supposed to mean something to me?"

"It means something to your secretary."

"Then perhaps you should talk to her." He started to reach for the disconnect switch.

"Eighty-seven billion dollars," Rabinowitz said.

Rashtapurdi paused in mid-gesture. "You have an endearing way of making idle conversation, Ms. Rabinowitz."

"I understand Indra Entertainment is the legal successor to dozens of Indian movie companies from the mid-twentieth century. Your library is said to contain well over ten thousand films, valued at around eighty-seven billion dollars."

"My publicity department has obviously done its job well."

"But it's not worth eighty-seven billion dollars to you," Rabinowitz continued. "You can reprocess the films with every new technology that comes along and copyright each new version, but the basic library itself is world domain. It's only worth all that money to the UN, because they're the only ones who can license it."

"I fail to see your point—if indeed you are making one."

"Have you ever been to Jenithar, Mr. Rashtapurdi?"

"Not in person. I did try once, but the local authorities are overly strict about who they will let teep there. I committed some indiscretions in my youth, a misunderstanding with the law, and the Jenitharp used that as a pretext to deny me access."

"That is a shame. You might have found it quite familiar. Jenithar is a grossly overpopulated world and very class-oriented, much like twentieth-century India. Perhaps its people would share the same values with those olden-day filmmakers. The films in your vaults, even as outmoded as they are by our modern standards, might be worth a great deal of money

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if they could be sold there."

"Are you offering your brokerage services to sell the films on Jenithar, Ms. Rabinowitz?"

"Of course not. I operate within the law."

"Then this conversation has been a waste of both our time." Rashtapurdi severed the connection.

"Oh no it wasn't, Mr. Rashtapurdi," Rabinowitz said quietly to the blank screen. "I never told you I was a literary broker. You already knew that when I called."

The next day Rabinowitz placed a call to third level constable Feffeti rab Dellor on Jenithar, who told her Chalnas was not allowed access to veering units, though he could have physical visitors. When Rabinowitz told him she had to ask Chalnas about some details of her business deal with Levexitor, Dellor even gave her clearance for a short visit, under rigidly supervised conditions. She thanked him and, with a sigh, veered to the rent-a-bod agency.

The process was mercifully short this time. With her status already on file, it was merely a question of finding the proper size body. As it turned out, there was nothing in her size available at the moment.

"This sort of thing can in future be avoided," the clerk said. "As I told you last time, we can for a very reasonable fee set aside the perfect body for you, ready at any time to be activated by you without further inconvenience."

"I don't think I'll be teeping to Jenithar all that often. I'd be willing to settle for a slightly smaller body, if you have one."

"Indeed we do, though you must sign a waiver relieving from all responsibility this company."

Rabinowitz did so gladly, and less than an hour later she stood in a visiting cell as Chalnas was brought in to her. He was far smaller than she was, and much of his plumage had been thinned out. Prison life must not be agreeing with him.

"Hello Chalnas," she said. "I'm sorry to see you under such tragic circumstances."

"It has always been an honor to serve your needs, Ms. Rabinowitz."

"Then tell me the truth: Did you kill your master?"

"Absolutely not. It would be unspeakable to break so sacred a trust."

"I believe you. But your police don't care about my opinions, so we'll have to bombard them with facts. Tell me your side of what happened that day."

"I was working as usual in the Highest's office up until an hour before the time when they tell me the murder occurred—"

"You were working that day? Levexitor said it was your day off."

"No, I was working. Then a call came in on the Highest's personal line. He grew very agitated, then told me my services would not be needed for the rest of the day. He practically pushed me out of the house."

"Do you know who that call was from or what it was about?"

"No, Ms. Rabinowitz, I do not."

"Had he ever had calls like that before?"

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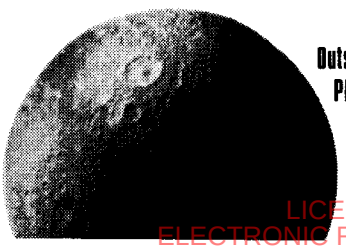

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"Several times over the past few months. Frequently he would tell me to go home. I think there was someone he did not want me seeing."

"That's a good bet. What did you do when he shooed you out on the day he died?"

"I went home, as he suggested."

"Can the cab driver verify your story?"

"I could not afford a cab, Ms. Rabinowitz. I walked home."

"Did anyone see you?"

"Thousands of people saw me, but no one knew me. I have no way to prove I was not in the Highest's house at that time."

"No alibi. OK, then tell me this: Do you know anyone named Raj-Pen Dewahl?"

"He is a petty merchant hoping in a hurry to make himself tall. He has always been hovering around the edges of the Highest's deals, hoping to grab some leavings for himself."

"Do you think he might have killed your master?"

"I don't think he has that much originality of thought."

"My feeling, too. Have you heard the names Peter Whitefish, Jivin Rashtapurdi or Nils Fredericksen?"

"Peter Whitefish, yes. He was another broker from Earth that the Highest had some dealings with. Occasionally I was excluded from their meetings, but I don't think it was he who made those suspicious calls. That would have been someone of a much greater size than him. The other two names I have not heard at all. I am sorry."

"Don't be. There's no reason you should know them." She paused. "What about a Detective Hoy, a policeman from Earth?"

"I believe he called several times. The Highest refused to speak with him."

"Well, he had some taste. I want to thank you for talking with me. I hope I can do something to save your life."

"My life is probably forfeit, but I appreciate your efforts, Ms. Rabinowitz." Chalnas looked the picture of despair as his guards escorted him once again from the visiting cell.

She found a message from Detective Hoy on her phone mail when she returned home. "I think we need to have a talk, Ms. Rabinowitz," he said. *"Peter Whitefish is dead."*

"Miami Beach?" Rabinowitz said.

"Well, it seems he had a beach house there." Hoy sat across from her in the parlor, immaculately dressed and ogling her with his usual intensity. "Maybe he felt safer there than New York."

"But why should Interpol concern itself with an ordinary mugging?"

"He was found in an alley. He'd been beaten, then stabbed with a hunting knife you could buy at any hardware store. All his cards were taken; the Miami police had a hell of a time identifying his body. An ordinary mugging. A studiously ordinary mugging."

"They've been known to happen."

"Not to people on my list."

"It's getting shorter, isn't it?"

"A lady's not supposed to notice such things."

"A lady's not even supposed to be

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involved in such things," Rabinowitz said. "But since I'm on the list and someone tried to kill me, I can't help taking perverse curiosity in it."

"There was a message from you on his phone mail."

"As if you had to check his phone mail to know that."

"Please, Ms. Rabinowitz. Allow us to keep up at least the appearance of innocence."

"Neither the believer nor the atheist is completely satisfied with appearances. And why shouldn't I call him? We're in the same business. Or were."

"Will you miss him?"

"Like a mildew stain in the bathroom."

"A man of tarnished ethics, as I understand it."

"Tarnished?" Rabinowitz chuckled. "I doubt that very much. His ethics were bright and shiny and new. They'd never been used. He attracted bright young writers to sign with him, then stifled them. His contracts were so tight his clients had to sacrifice all their early work to get out of them—and I know quite a few that did. There may be tears at Peter's funeral, but they won't be of grief."

"Sounds like you're the perfect suspect for his murder."

"I have no motive except for the strictly intellectual one of purifying my industry. And you *know* I haven't been to Miami lately."

"As a detective, I just despise coincidence."

"Really?" Rabinowitz smiled broadly. "Let me share some more with you, then. Levexitor is dead. Whitefish is dead. I was very nearly dead. And one thing we all had in common was an Interpol detective with a conspiracy theory. Is it just coincidence that you're linked to all the murders, actual and attempted?"

Hoy nodded. "An interesting hypothesis. It has a certain naïve charm and simplistic elegance. It's utterly wrong, of course, but worth considering for a few seconds. Since I know I'm innocent, I hope you won't mind if I just discard it out of hand."

"And since I know *I'm* innocent, we can remove me from the picture, too."

"Nice try, Ms. Rabinowitz. Well, as you said, the list is getting shorter all the time. If I wait long enough, I'll just have to arrest the last person standing."

"Since I don't intend to fall and since I've committed no crimes, I find that unacceptable. You'll have to rein in that police mentality of yours." She stood up. "Now, if you don't have any other startling news for me—"

Recognizing his cue, Hoy stood too. "I certainly hope I don't have to arrest you. Although I do know a few games we could play with handcuffs."

"Tell you what. Start without me and I'll catch up. I'm overdue right now for an appointment where murder is much more straightforward."

Hoy looked at her curiously. "Where's that?"

"Eleventh-century Scotland."

It was nighttime in the courtyard, black and gloomy in many places with just occasional spots lit by torches. The castle walls, when they

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could be seen at all, were stone and mortar, solidly built to withstand the most punishing assault a medieval Scotsman could conceive. A group of people, some in period garb and some casually modern, were standing around talking as Rabinowitz walked on from stage right.

"Sorry I'm late, people," she said hurriedly. "The director should set an example—"

That was as far as she got, as the others burst into applause and several of them rushed over to see how she was. "We're just glad you're here at all," one young woman said. "Especially me. They expected *me* to direct. I'm just a stage manager."

"Thank you, Fran," Rabinowitz said, "both for saving my life and for doing my job. I'm sure you were wonderful." Several of the other people nodded.

"It's too much work. I just want to solve problems and deal with disasters. You can tell them where to stand."

"To be quite honest I'd rather be here putting you all through your paces than lying in a hospital bed."

"Someday I'll remind you you said that," Fran promised.

Rabinowitz looked the group over and couldn't help but smile. For a totally amateur group, they were some of the finest actors she'd worked with—though she had a feeling that her lead actor, Kwame Massala, would not be an amateur much longer. In the old days when stage actors had to play in person, the stockbroker from Capetown would have been trapped playing Othello forever; in a VR theater he could portray anyone from Romeo to Lear convincingly. Right now he was a burly Scotsman with ginger hair and mustache, and piercing brown eyes glinting with ambition. It was just a matter of time before he got the recognition he needed to make the jump as a pro.

"Well, regardless of how glad you are to see me," she said, "the fact is I've cheated you out of some precious rehearsal time, and we'll all have to be brilliant to make up for it. How far have you gotten?"

"Run through on Act I, a complete read-through on Act II," Fran said.

"Then I guess we're ready to try a run-through. Places, people—Banquo, Fleance, Macbeth and the silent servant. Let's see what we can do."

Rabinowitz momentarily put aside her personal concerns, all the dead bodies that were piling up in the real world, to concentrate on the regicide about to occur in this theater. She listened, but was not transported. The words were all there, punctilious and precise. Just the spirit was missing. Banquo wasn't supposed to be dead until Act III, and Macbeth might as well have been considering his options on different stock deals.

How could she make this play come to life? Part of the problem was that she much preferred the comedies; she dealt with heavy enough matters in real life. But the troupe had outvoted her on this one. They wanted to try the Scottish play. And now it was her job to make it live. Everyone was looking at her. She had to say something.

"Fine-o, here's my tilt on it. Ban-

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quo, you're in a whiz. You heard what the sisters said as well as Mac did. He'll be king, but you'll beget kings. Does that mean your pimply-faced little Fleance gets a crown? Glamis and Cawdor both came true. And here everyone is—Mac, Duncan, Fleance—all within one set of thick stone walls for the night. Is it any wonder 'A heavy summons lies like lead upon me,/And yet I would not sleep; merciful powers/Restrain in me the cursed thoughts that nature/Gives way to in repose.' Mac's an old friend, but can you suddenly trust him in the dark with a dirk?

"Fran, I think we should do a little more with the dagger of the mind. You're projecting it straight in front of Mac. 'I have thee not, and yet I see thee still.' Sure holographic projections weren't that common in eleventh-century Scotland, but we have to play to the audience, who's seen a lot of them. The dagger isn't just a visual effect to Mac, it's a symbol, a key—yes, his key to heaven, to everything he wants, if only he dares grasp it. Yes, it's the key to heaven, so it comes from heaven. Fran, we'll float the key down from the sky. It'll even start coming down before the servant leaves, only he can't see it. Only Mac can see it. He'll look up and there's this dagger floating down, the handle towards his—"

She stopped suddenly and her eyes focused on some indefinable point light-years away. "He'll look up and see it come down," she whispered, her voice barely audible to the others. She stood transfixed for nearly a minute. The rest of the troupe waited, not knowing whether to disturb her.

She shook herself out of it and looked around, as though for the first time. "Oh my God," she said. "You're all going to hate me, but I have to leave now. Fran, I owe you a big, big favor, but please take over one more time. This is the last time, I swear it."

"Where are you going in such a rush?" her assistant asked.

"I have to catch a plane to New York," Rabinowitz said as she vanished from the virtual stage.

The big brownstone house was dark, which surprised her; she'd phoned ahead to let Fredericksen know she was coming. She climbed the front stairs and knocked. No answer. She tried the buzzer. Again, no answer. She tried calling in on her handphone. Just the message machine.

"Did he jump out on me?" she muttered.

She tried the heavy front door and found to her amazement it wasn't locked. Something was not right. Fredericksen had the normal urbanite's finely honed sense of paranoia. Even if he'd left, he'd have locked up behind himself.

Standing to the side of the sill she pushed the door inward. "Nils?" she called. Silence answered.

She stood for a moment beside the doorway, thinking, then slipped quickly inside. Inside the house was as dark as it had looked from the outside. The house system must have been off, because the motion detectors didn't activate the lights as she moved around. Nor was there a man-

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ual switchplate beside the door. It had been years since Rabinowitz had last visited. She couldn't even remember where the switchplates might be.

"Nils," she called again, but this time her voice was much softer. Even if Fredericksen had been in the next room he might not have heard her.

She left the door wide open to let in a faint beam of light from the street outside. Searching her memory for clues to the house's layout, she moved to her right and bumped into the sliding double doors that led to the study. The wooden doors were closed. Why?

Feeling the surface of the doors with her fingertips, she found the crack where the two doors met. Again standing slightly to one side of center, she pulled the doors apart. The doors slid into the walls with just the faintest squeaking. There was more darkness and silence in the den beyond.

Wishing she'd thought to bring her MagLite, she took a step into the room, then a second. Her third step was interrupted by a large lump on the floor. She tripped and went flying forward, putting out her hands to break the fall. Somehow, by sheer dumb luck, her head missed bumping on the edge of the heavy desk by just a few centimeters, and she lay on the carpet panting.

Now there was the sound of movement. Someone had been standing, waiting on the far side of the room, and now he was rushing toward her. Rabinowitz scrambled to get to her hands and knees, but suddenly the other person kicked her in the stomach and she fell back onto the floor. Looking up she saw standing over her a body silhouetted against the meager light from the hallway. In its hand was the silhouette of a gun.

A gunshot echoed in the room, and Rabinowitz's body jerked in anticipation of a bullet that never came. Instead, the person standing over her fell hard against the desk and then crumpled to the floor beside her.

A bright light shone suddenly in her eyes. She shut them tight and turned her head to the left, where the body had fallen.

"I've been finding you on the floor a lot lately," Detective Hoy said. "Is that one of your preferred positions?"

Rabinowitz squinted her eyes open again after Hoy pointed the light away from her. She rolled over and once more started getting to her hands and knees. "What took you so long?"

"Well, if you want prompter service, stop making spur-of-the-moment plane flights," he replied. "I had to improvise like a loono to stay this close behind you. What exactly's happening here?"

There were several shapes moving around behind Hoy. "Have one of your people find a switchplate," Rabinowitz said as she got to her feet, "and we'll both know."

The lights came on just as she finished speaking and she had to shut her eyes for another few seconds until she could adjust. She opened them slowly to stare down at the still figure of her attacker, a man dressed all in black.

"Know him?" Hoy asked.

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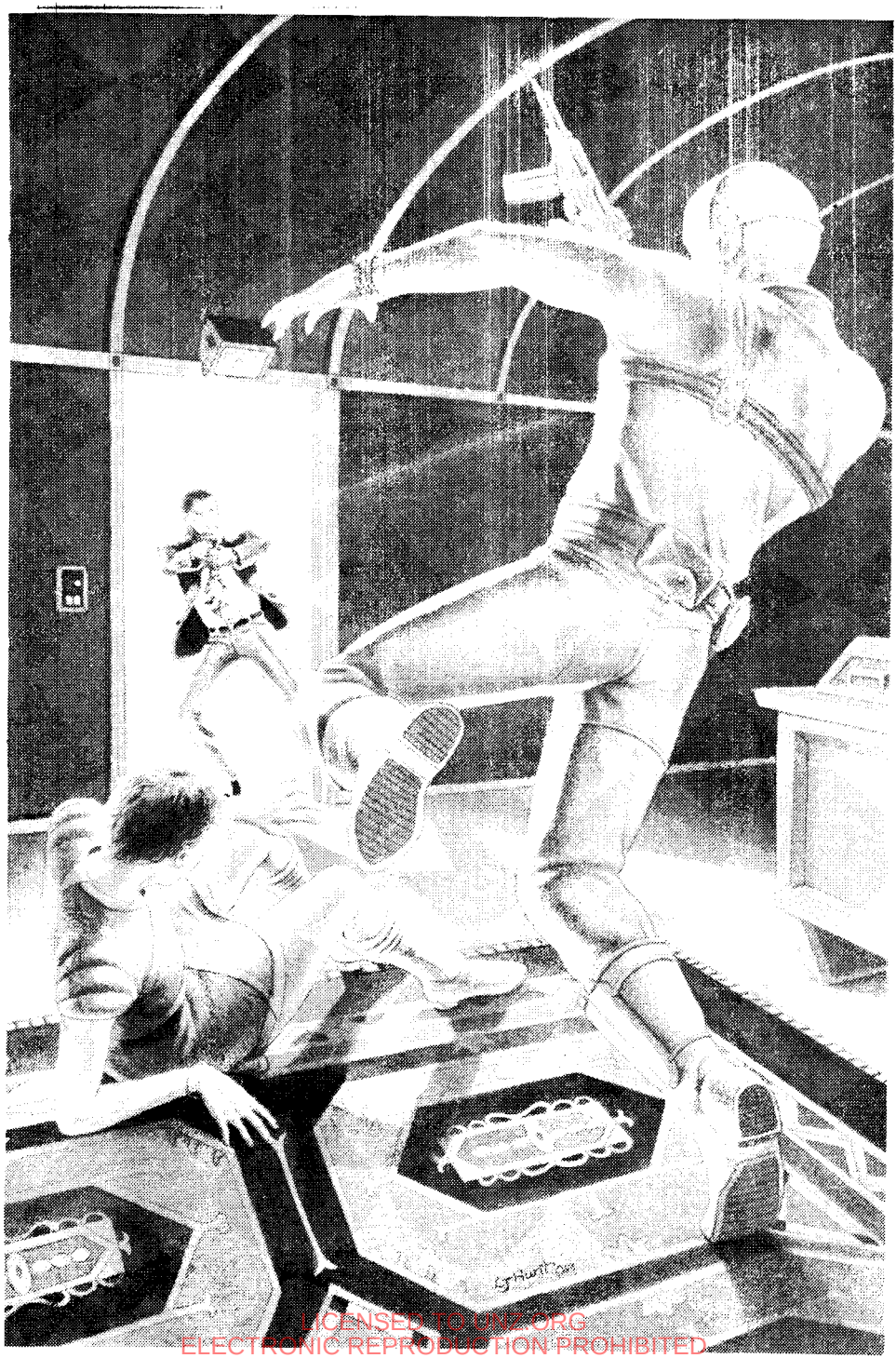

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"Never saw him before."

"I doubt whether anyone around here has. Probably one of Rashtapurdi's hired thugs. No need to ask you about the other one."

Rabinowitz braced herself and turned slowly. The object on the floor that had initially tripped her was another body—Fredericksen's body. She stared down at it, feeling an inner hollowness but no surprise. "I think indirectly I killed him," she said quietly.

"Care to explain your reasoning on that?"

"I called Nils from the airport to let him know I was coming over. That probably panicked Rashtapurdi."

"Why would that panic him?" Hoy asked.

"Because I knew and I could prove that Nils killed Levexitor."

Hoy arched an eyebrow. "How?"

"For one thing, he made a tiny slip I didn't even notice at the time. When he called me shortly after the murder, I told him I'd been present when Levexitor died. I never said 'murdered,' but Nils asked me if the police had any idea who killed him."

"That's pretty flimsy," Hoy said. "We live in a violent society. It's natural to assume a violent death. If I took that to a prosecutor I'd be laughed out of his office."

Rabinowitz walked slowly over to one of the large armchairs facing the desk. The kick to her stomach had made standing uncomfortable. "Levexitor himself gave me the biggest clue," she said as she sat down.

"Did he come back from the grave, or wherever Jenitharp dispose of dead bodies?"

"No, but the scene is sharply etched in my memory. Levexitor was calmly talking to me, then suddenly he looked up, cried out and slumped over his work table."

"So?"

"Up," Rabinowitz said wearily. "He looked *up*. That's such a simple gesture for us, but it has a whole new world of meaning on Jenithar. Levexitor had the title 'Highest'; he was among the tallest on Jenithar. There could only be a few people on the planet he'd look *up* to, and certainly not his assistant. Chalnas would have to stand on a ladder to do that, and he could hardly have surprised his boss that way."

"What about Rashtapurdi?" He's an entertainment mogul, very important—"

"He's also a convicted felon. The Jenitharp keep them out on general principles—very commendable in Rashtapurdi's case. No, I wasn't thinking in terms of money. The Jenitharp don't care about that nearly as much as they care about status. Say, someone with the rank of UN Secretary for Interstellar Commerce."

"I'm sorry to burst your bubble, but Fredericksen had a pretty tight alibi. At the time of the murder he was attending an opera on Dikwan. Lots of people saw him. I checked that out myself."

"Have you ever seen a Dikwanic opera?"

"Never had the pleasure."

"If you had you'd never use 'pleasure' in conjunction with it. I'm sure Nils had a rented body on Dikwan sitting at attention for hours in the audience, surrounded by people who'd swear he was there. But I know

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from personal experience how easy it is to slip out of that rented body and come home for awhile—or maybe even to rent a second body on another world. Nils told me he'd been to Jenithar a lot in the last year. They've got a system that bypasses all their paperwork and lets you keep a body on permanent reserve. He could have slipped into that without anyone seeing him and gone to visit Levexitor. That body would have been as tall or taller than Levexitor's—and the heavy metal arm would be the only murder weapon he needed. If you look a little more closely at Nil's phone records, I bet you'll find that 'simultaneous' jump."

"You've got means and opportunity, but you haven't mentioned motive," Hoy said.

Rabinowitz sighed. "Well, I think he killed Levexitor in simple panic. Levexitor was having second thoughts and was about to tell me what he was mixed up in when Nils struck him. Knowing Nils, I'll bet he was horrified at his own actions. But his larger motives, why he was in this deal in the first place—we'll just have to guess. I do know he was upset about losing the secretary general post to Chien, far more than he let on. Maybe he wanted to start a scandal to embarrass Chien. Maybe he wanted to get what was coming to him after so many years of service. But beneath it all he was still a patriot. Look what he chose to steal. The Indians made those movies by the thousands, the ultimate potboilers. Not even their creators would call them literature. They're some of Earth's assets, sure, but we'd never really miss them."

"What about the attacks on you and Whitefish—not to mention that assassin on the floor over there?"

"Nils would never have done anything like that. You can lay those to Rashtapurdi, the real villain of the piece. When the deal started unraveling he just decided to cut off the loose ends. Now there's no one to give hard evidence against him. Want to bet he walks free from this?"

"No taker. May I call on you socially now?"

Rabinowitz looked at him, horrified. "I have just dealt with the shock of having a man I cared about, someone who raised me like an uncle, be a murderer. And then I trip over his dead body. How could you possibly suggest such a thing?"

"I did save your life twice."

"It wouldn't have needed saving if you hadn't put me on that list of yours."

"Oh, that. You were never really on it, you know. Fredericksen put some political heat on my bosses and they wouldn't let me go after him directly. I had to try a more roundabout route."

"I see." She stood up and started for the door.

"May I at least call you Deborah?"

She looked him dead in the face. "I don't have relationships with men who use me as a tool."

"Well, that's OK, too," Hoy said amiably. "How *do* you want to be used?"

"I really don't have the time for this," Rabinowitz said icily as she brushed past him."I've got a regicide to manage and a civil war to plan. Birnam Wood doesn't move by itself, you know." ■

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Stephen L. Gillett, Ph.D.

THE ENVIRONMENT, TECHNOLOGY DRIVERS, AND NANOTECHNOLOGY

There's nothing like limits on old technologies to inspire new ones!

We all know what technology drivers are: they're high tech, cutting-edge research projects that push the state of the art, and they typically require zillions of dollars of up-front government investment. The Space Program. The late, lamented Superconducting Supercollider. SDI. The X-15. And so on.

And we all know what environmental regulation is: a diabolical invention of naive, anti-technology, tree-hugging "greenies" that's crippling industry and quashing the entrepreneurial inventiveness that's the hope of Western civilization. And the naive and atavistic desire to "return to the land," of which environmental regulation is merely an expression, will doom billions to starvation should it ever take hold as a serious economic and political program. . . .

Well. 'Tain't so. Not completely, anyway. Environmental requirements are forcing a pathway by which we'll achieve nanotechnologies—a route that's been largely unexplored in the literature. In fact, environmental requirements are proving to be far more effective technological drivers than the traditional examples.

And we'll even have some natural Earth left to enjoy to boot.

How on Earth? I'll justify this notion in the rest of the article.

* * *

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Nanotechnology fundamentally is "design at the molecular level": a place for every atom, and every atom in its place. Generally, though, it's presented as nano*machines:* tiny constructs with moving parts the size of molecules. In fact, a favorite SF device has become little autonomous bugs scurrying around doing all manner of wondrous things, from clearing the sludge out of arteries in living people to automatically assembling everything from giant space structures to the day's clothing and furniture.

These bugs are often viewed as self-replicating, to boot, just like biological bugs. This stems from the sheer tininess of atoms, which means you need very rapid assembly to build macroscopic objects in something less than geologic time. Self-replication is obviously a way to get very rapid assembly indeed, through the miracle of exponential growth. Self-replication leads to all sorts of imaginary disaster scenarios, though, the so-called "gray goo" problem: a hypothetical takeover of the Earth (and maybe the entire Galaxy?) by replicators run amok.

All this hype is, to put it mildly, grossly premature. (I've been a skeptic about the nanohype for some time—look at my letter in the Dec. 1988 issue. The timescales are gravely accelerated; the notion that having bugs to clear out one's blood vessels, or whatever, is just around the corner is simply laughable.)

Nanomachines versus nanostructures. But that doesn't matter. There are much nearer-term applications for nanotechnology, applications that are going to make some people very wealthy indeed by the first part of the next century. To see them, we have to return to first principles: why are we thinking of nanotechnology as nano*mechanical?* Macroscopic experience says that designs with lots of moving parts are the most difficult and failure-prone; how many times have we heard "no moving parts" as a mantra of reliability?

Lots—*lots*—of other applications could use molecular *design* without necessarily being molecular *machines.* That's nanotech too, according to the definition—they're certainly designed and built at molecular scales, with (at least in theory) a place for every atom, and every atom in its place. But to distinguish them from the nanobugs, I'll call them nano*structured* materials.

Perfect crystals, both for structural and optical applications, are one example. A routine demonstration in Solid State Physics 101 is that macroscopic materials are a couple of orders of magnitude weaker than the strengths of the chemical bonds in them would imply. The reason is that the boundaries between separate crystals dominate the strength of macroscopic materials, and the bonding across such boundaries is far weaker than that within the crystals themselves. So defect-free crystals will be far stronger than anything we have today. A skystalk to geosynchronous orbit made of (say) perfect diamond fiber may be a possibility—if we can spin out such fiber by the megaton.

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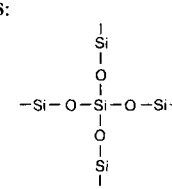
Of course, we don't have to stick with pure substances. Materials composed of two or more mechanically intertwined substances—composites—are a big deal in materials science right now, and *nano*composites are on their way to becoming an even bigger deal. This is why biological products like shell and wood work so well, despite being made of such unpromising materials: they're nanostructured composites. Imagine, then, what will be possible using materials like (say) graphite fiber and steel, instead of carbonate crystals, proteins, and cellulose.

Nanostructured electronics are another big research push now; indeed, they're an obvious goal of microelectronic trends. As miniaturization continues, we'll be pushing the "quantum limit" in a few years, where the quantum-mechanical behavior of electrons becomes first important, and then overwhelming. Conceptual models of electrical behavior that have served electrical engineers well since the days of crystal sets break down at these nanoscales. On the other hand, a truly atomic scale electronics implies staggering levels of miniaturization. It would be "electronic" in the most literal sense, with "one electron, one bit" a possible goal.

And some nanostructured materials will be completely new materials, with at least the potential for completely new applications. Atomic clusters dispersed in zeolites are one example, which I'll use for illustration.

Let me first describe zeolites. For those who haven't run into them before, they're a type of "framework" silicate. Framework silicates ("tectosilicates") have a chemical structure like this:



That is, every silicon is hooked to four oxygens, and every oxygen is hooked to two silicons, to give an overall 3-D framework that extends indefinitely. You can't show it on a flat page, but the four oxygens around each silicon are arranged in a regular tetrahedron, with the silicon in the exact center. Another way to visualize the framework, then, is as an infinite network of (SiO_4) tetrahedra, all connected at each corner where they share oxygens.

If only silicon and oxygen were involved, the overall formula of such a structure would be just SiO_2—that is, just silica. Other atoms—aluminum, in particular—can substitute for silicon, though, and that gives lots more variety. Since aluminum has a $+3$ instead of a $+4$ charge, this gives a net negative charge to the whole framework. Positive ions are tucked into the framework, usually at specific sites, to maintain charge balance.

Such common minerals as feldspars and quartz are framework silicates. Zeolites differ from these minerals, though, in that the framework is much more open, almost like a scaffolding. Thus molecule-sized voids and tunnels, whose size and shape de-

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pend on the zeolite, extend throughout the crystal; and *this* means different zeolites can be very specific indeed for absorbing certain molecules and rejecting others, depending on whether the species fits into the holes. For this reason zeolites and related compounds are commonly called "molecular sieves"—but much more on *that* anon.

Anyway, dispersing clusters of atoms in the voids of a zeolite crystal gives that substance utterly new electronic and optical properties. For example, one research group has studied cadmium sulfide clusters—groups consisting of 4 Cd and 4 S atoms precipitated into the voids of zeolite Y. The "crystal" spacing of these clusters is obviously very different from that in a bulk CdS crystal, so the electronic interactions between the clusters are also very different. (Since the silicate "backbone" is pretty inert, it doesn't affect the electronics much.)

So, not just new mechanical properties are possible with nanostructured materials; new optical and electronic properties will be possible as well.

They're a lot simpler than nanomachines, too. Not only will they be easier to build, but they're a lot more failure tolerant. That seems intuitively obvious, of course, but I'll elaborate on it a bit. Eric Drexler, in his excellent book *Nanosystems* (Wiley, 1992), analyzed nanomachines theoretically for failure modes. His analysis, though, assumed "point" failures; that is, the conditions under which one specific subsystem would fail and thereby incapacitate the nanomachine.

Such an analysis leaves a gap big enough to drive a semi through; it does not address *system* failures, what might be called "Tacoma Narrows Bridge" scenarios. The original Tacoma Narrows Bridge was a narrow, graceful suspension bridge across the southern part of Puget Sound from Tacoma to the Kitsap peninsula, in Washington State. It was built about 1940 and went tumbling into the Sound several months later. A strong wind blowing down the Sound had excited major oscillations in the bridge, through mechanisms that are still somewhat controversial, and those oscillations built up until the bridge tore itself apart. (A spectacular, albeit grainy, film of the Tacoma Narrows failure is today shown in all civil engineering classes, and the disaster also had a supporting role in Clarke's *Fountains of Paradise*.)

This was not a point failure; there was nothing wrong with the steel of the span itself, nor with the cables holding it up, nor with the towers to which the cables were attached. It was a *system* failure: the structure *as a whole* was inadequately damped for those vibrational modes.

This failure is an example of the whole problem of "emergent properties" in complex systems; the fact that ensembles consisting of huge numbers of interacting parts exhibit behavior that isn't predicted by the properties of the constituent particles. (Imagine trying to predict the behavior—indeed, the very existence—of weather from the properties of H_2O and air molecules!)

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To put this in the context of nanomachines: Drexler treats the nanomachines as being mounted on a rigid framework, probably made from diamond-like carbon. Now, there are good reasons for rigid mounting, as it would minimize dissipation of energy. This in turn means less heat will be generated, a big consideration as cooling such tiny devices presents a huge challenge. But imagine something—a *rigid* something—containing (say) 10^8 moving molecular parts. How do you keep the thing from shaking itself to pieces? All those hurtling molecular parts, typically moving at speeds of several hundred meters per second, are going to try to excite coherent oscillations of the entire system, including that rigid framework. Not only that, but those phonons (lattice vibrations) will themselves dissipate energy, which will be promptly thermalized into the framework.

The device may melt before it flies apart.

Now, this presumably could be designed around; my point is that designing such nanomachines is a far more difficult problem than even *Nanosystems* acknowledges. A further problem, moreover, is such machines' encounters with the real world. With all the multifarious molecules lurking out there in the environment, *something* will be able to gum up the nanoworks. (Toxicity—the gumming up of biological molecular machinery by the wrong stray molecules—remains a problem for biological systems!) By contrast, the only moving parts in nanostructured materials are electrons, which don't count. And even if they do get gummed up here and there, by a stray molecule or two, they won't fail.

By the way, biosystems avoid "vibrational" failure because they're *not* rigid: they're instead made of squishy little bags of solution chemistry (i.e., cells). Since they can't vibrate coherently, there's no chance that motions of individual atoms will induce destructive oscillations of the whole system. (Biosystems are prone to other sorts of system failures, though.)

Nanostructures and non-thermal technology. In a previous article ("Beyond Prometheus," Dec. 1993) I talked about "non-thermal" technology as the next broad step in technological development. I pointed out how much of our present technology relies on heat, and how this pervasive reliance indicates we're still living in the "Paleotechnical Era."

One example is element separation. Most of our present resource extraction techniques use a paradigm that hasn't changed since antiquity. It may be summed up as "heat and cool and wait for phase changes." We use the automatic partitioning of elements between two different phases (liquid versus vapor, say) to separate out the one we want.

For example, iron ore (basically an iron oxide with silicate impurities) is cooked with carbon (coke). At high temperature, the carbon reacts with the oxide to form CO, which escapes, and the silicate impurities form a "slag" that's immiscible with the molten iron—just as oil and water are

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immiscible. So you can drain off the iron and throw the slag away.

It's simple, sure, but it's *exceedingly* inefficient because of all that heat. Thermal extraction also requires concentrated feedstocks—"ores"—because you don't want to heat up any more material than you absolutely have to, and because the thermal partitioning is not 100% efficient. And last, thermal extraction is terribly dirty, not only because you always lose some of the desired element into the "other" phases (some iron always goes into the slag, for example), but also because of the combustion products from the fuels you burned.

We could do a *lot* better; and as I pointed out, biological systems already do a lot better. They certainly provide the proof of concept. But most biological (and biological-like) systems are unnecessarily complicated for a non-thermal extraction technology. They're the nanomachine approach again. Nanostructured materials provide an obvious alternative approach, and indeed it's one we're already taking in embryonic form. We're not very good at it yet, though, because our nanostructures still aren't very good.

One type is semipermeable membranes: molecular layers that allow certain molecules from a solution to pass through, but exclude others. In reverse osmosis, a membrane under pressure passes certain solutes only. In electrodialysis, an electric field applied to complementary membranes pulls dissolved ions (charged atoms) out of a solution, the positive ions through one membrane and the negative ions through the other. ("Dialysis" in general is the purification of a solution by differential passage of solutes through a membrane or other "sieve.")

Indeed, such membranes bring us back to the idea of molecular sieves. Why not use something like zeolites to literally strain certain molecules (hydrocarbons, say) out of solution? Unfortunately, we run into a limit of current technology, as we currently can't make zeolites in anything but small crystals! Macroscopic zeolite films or crystals would be dandy, but we can't build them yet.

Yet another approach would be "ion pumps"—similar to what biological systems use. These are channels through membranes along which ions are forced to flow by chemical means, against the concentation gradient. Ion pumps are how cells regulate their internal chemistry. They're how vertebrate kidneys work, too, and are why natural dialysis is still so much more efficient than the artificial version. As I noted in "Beyond Prometheus," kidneys manage to extract certain solutes, out of a background of lots of solutes, all without phase changes—vaporization, freezing, et cetera. But they manage to do this only by being structured at molecular scales.

Ion exchange is another common non-thermal extraction technique. Dissolved ions attach themselves to a specific site ("ligand") on a membrane or surface, displacing the previously attached ion when they do so. Generally the ligand is an organic side

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chain that also has an electric charge. The ligand's nanoenvironment—its shape, and distribution of electrical and chemical properties—are such that it binds to particular ions particularly well.

Ion exchange is good for purification, as the sites are extremely sensitive to small differences in binding energy. This is how you can use ion exchange to separate things with very similar chemical proerties, such as the rare earth elements. It's also now used on a large scale for such things as water softening, and also to extract heavy metals from wastewater effluents.

Current ion-exchange is still polluting, though. The problem is that "exchange" of the ions. When you take out (say) a lead ion, you must put something else back in to maintain charge balance. The "something else" is typically a more innocuous ion (obviously it's an improvement if you swap, say, calcium for lead) but something still stays dissolved in the water.

Things like water softeners are currently even worse. When you "soften" water, you take out calcium ion (which gums up with soap) and replace it with sodium ion (which doesn't). Unfortunately, sooner or later the ion-exchange resin in your softener fills up with calcium, at which point it stops working. You then need to "recharge" it; replace the Ca ions with Na ions that can again be exchanged. And to do this, you have to put a *very* sodium-rich solution back through the resin, to overwhelm the preference of the exchange sites for calcium.

Of course, as anyone with a softener knows, you recharge with brine—ordinary NaCl solution. This leads to a pollution problem, as all that used brine then just gets dumped into the wastewater stream. The upshot is that ion-exchange alone is not sufficient: the water never gets less salty. At best you just replace toxic ions with nontoxic ions, and at worst, the water gets saltier and saltier, because you have to recharge your exchanger once in a while. Another problem, too, is the "anion problem." Current ion-exchange resins don't exchange anions (negatively charged ions) well; they're just not as distinctive. But some of them are toxic or valuable too.

We need in addition *de*ionizing, via reverse osmosis or electrodialysis or ion pumping or some such, to remove solutes completely, not to just swap them out.

We need an industrial kidney. Badly.

Catalysts are another very broad area of non-thermal technology that is driven by nanostructured materials. Certain zeolites, for one thing, are used for catalysis. Put hydrogen ions, rather than metal ions, inside the negatively charged aluminosilicate framework, and you've got a "fixed" acid; a source of acidity (hydrogen ions) in which the ions stay put. Furthermore, this acid, tucked away inside the crystal, will react only with certain things: those that can fit through the holes in the zeolite. Alternatively, you can put ions such as nickel or iron, which are also good

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at catalyzing specific reactions, inside the zeolite, and again they'll catalyze reactions only with molecules that can fit through the holes. In fact, zeolites are so specific in the reactions they catalyze that they're commonly compared with biological enzymes.

Other routine industrial catalysts involve reaction on specific surfaces; a metal or oxide layer, for example. Traditionally, preparing such catalysts has been a "black art"; the catalysis occurs because of minute details of the (very complicated) electronic structure at the surface, from such things as adsorbed atoms, surface effects, and so on, and understanding—much less control—of what was going on was lacking. But progress in understanding exactly what's happening in surface catalysis, at an atomic level, is being made (at least two journals are devoted to the subject); and being able to design specific catalyst surfaces to do exactly what we want to is no longer a far-off dream. Then all we need to do is build them, at the molecular level.

You also can see there's a general connection with electrochemistry in most of these applications, as chemical reactions fundamentally involve interactions between the electronic clouds around atoms. (Or, as electrochemists like to say, "all chemistry is electrochemistry.") Because of such considerations, a big literature is developing on nanostructured electrodes and "electrocatalysis"—the controlled driving of chemical reactions by applying an electrical potential. By varying the electrical potential, you can actually affect the electronic structure of the atoms in the electrode, with tremendous possibilities for controlling chemical reactions at the molecular level—but again, only if the electrode's molecular organization itself were also precise enough. This is an elegant technological application for nanostructured materials, a blend of fundamental chemistry and microelectronics. It's also one that nature *hasn't* already stumbled into, either.

NANOSTRUCTURED MATERIALS AND THE ENVIRONMENT

What has all this got to do with the environment? That's, after all, what we started with!

Pollutants as resources. It's because a great deal of environmental regulation stringently limits the concentration of various substances (elements or compounds) that can be present in an effluent, such as wastewater or smoke. This gives industries a big incentive to remove low concentrations of particular contaminants cheaply. (Or else, of course, to redesign their processes so that the pollutants aren't there in the first place. But that's not always possible.)

And furthermore: if you can carry out such removal, suddenly you've gotten potentially useful materials out of your effluent streams. Waste becomes a resource.

This actually has been happening for a while. Sulfur dioxide, for example, is an abundant waste product (or by-product) from most smelting operations. Most ores of such metals as copper, zinc, and lead are sulfides,

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and their processing begins by "roasting" them in the air. This drives off the sulfide as SO_2 and leaves the metal as an oxide, which is then further processed. In the bad old days, that SO_2 was vented directly into the atmosphere. Now it must be removed, with the result that *lots* of cheap H_2SO_4 (the ultimate product of sulfur oxidation) has become a byproduct of sulfide ore roasting. One copper company in Arizona now uses this torrent of sulfuric acid to carry out "heap leaching" of very low-grade copper-bearing rock; pile the rock up, pour acid over it, and recover copper from the leachate trickling out the bottom. And such rock contains too little copper to be economic with conventional thermal processing. . . .

(Here's another measure of our technological infancy: roasting fundamentally is a dreadfully wasteful thing to do. Sulfide ores contain free energy, so thermodynamically we ought to be able to use them as fuel, and get the metal as a by-product! Chemolithotrophic bacteria come near accomplishing this, but we don't.)

Anyway, "cheap" contaminant removal in practice means non-thermal extraction. Let's look at the processing of wastewater solutions. They're an even more pressing problem, but they also provide excellent examples of pollutants as potential resources.

Several types of things get dumped into water that need to get undumped: dissolved species such as heavy metal atoms, biowaste such as sewage, and finally otherwise innocuous salts that increase salinity. (Salt isn't especially toxic, but if there's too much of it the water isn't good for much!)

Ion exchange is a good way to extract heavy metals, and it's practical even now. One processing operation in South Africa, for example, found that after new environmental regs forced them to remove manganese from their effluent stream, they could do so profitably. (So much for those Mean Ol' Environmentalists!) But obviously, precisely nanostructured ion exchangers, with every ligand in its proper place and able to interact with the solution around it, would be far more effective.

Again, though, the problem with ion exchangers is that they just swap ions. They don't remove them completely. So, as I already mentioned, we desperately need an "industrial kidney" to *remove* solutes, anything (or everything) from a nanoporous membrane that could (say) sift oil out of the water to a more active system such as an ion pump or electrodialytic membrane.

With sophisticated nanostructuring, we could build such a "kidney." And one will be built—the only questions are how soon and by whom.

Ultimately, we could even separate out the various isotopes in nuclear waste, if we could design systems that could "heal"—i.e., repair themselves when damaged by colliding high-energy particles and ionizing radiation. But here we're getting back into the realm of molecular machines. This would indicate, though, that the idea of "isolating" nuclear waste for

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10,000 years (the current plan) is irrelevant. It *will* be reprocessed one of these days; and probably sooner rather than later.

Other environmental regs deal with resource extraction. It's getting harder and harder to "permit" a new mine, for example. This gives additional incentives to extract raw materials more efficiently from existing mines, and further drives using waste as resource.

To sum up, pollution control and resource extraction are the same problem approached from opposite directions: in both cases, we want to remove a few particular atoms or molecules from a background of lots of other atoms or molecules. That's what plant roots and vertebrate kidneys do already, that's what nanostructured materials will allow us to do, and environmental concerns are driving us in that direction.

Somewhat ironically, Drexler described a hypothetical nano-extractor in *Nanosystems*. However, this was a nano*machine*; it was to be fed pure, simple feedstock materials from which it would pull out the particular molecules needed for assembly by another subsystem. This simplifies the problem greatly, because your nanomachine doesn't have to deal with the arbitrary messiness of the real world. But, in terms of real-world applications, it's putting the cart before the horse. We don't need to be able to pull particular molecules out of a clean solution consisting of just a few types of molecules; we need to pull a few molecules (or atoms) out of a background of *lots* of other molecules.

Element and molecule extraction aren't the only technology drivers. "Zero-emission" rules for vehicles are another driver. In effect, such rules mandate electric vehicles—and that is giving a big boost to fuel cells. A fuel cell makes electricity directly by reacting fuel and oxygen, without the inherent inefficiency of burning the fuel and then turning *some* of that heat into electricity. (As I described in "Beyond Prometheus," the Second Law of Thermodynamics places a limit, the Carnot limit, on how much heat may be turned back into useful work.)

Fuel cells are not Carnot-limited, as the fuel is not "burned." That is, the energy released by the chemical reaction isn't thermalized—turned into random molecular motions, in other words—but is put directly into raising electrons into high-energy states. This is done by carrying out the reaction in a highly controlled way. (The molecular machinery of living things does something similar, by the way; it's not really true to speak of food being "burned" by metabolic processes. Food energy is not converted into electricity, of course, but into other chemical forms that cells' machinery can use.)

In any case, such controlled energy release is made possible by highly structured materials. To put it differently, highly organized matter yields highly organized (i.e., non-thermal) energy. And finally, for fuel cells, nanostructured membranes are a highly promising approach both for achieving high efficiency, and for using a

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broader mix of fuels. The reason is that such membranes will allow the fuel and oxygen molecules to react individually, in a highly controlled manner.

A different constellation of applications lies in environmental remediation; that is, in cleaning up old pollution problems. A friend of mine who does commercial real estate has told me that significant tracts of property in this country, particularly in cities, are unsaleable and unusable because of pollution; either they're by old dump sites, or contamination has seeped in from other sources such as leaking oil tanks or industrial operations.

A technique that could cheaply and reliably decontaminate such areas would make a few billion. Imagine (say) little integrated packages, cheap enough (like memory chips?) that you could scatter them around a contaminated site, each sitting in a little pool of crud. Maybe they're solar powered, or maybe they're just plugged in. But, using a collection of molecularly designed membranes, exchange resins, and so on, they extract the toxic materials from the surrounding water; cheaply, quietly, and non-thermally. Or alternatively, they just break the pollutants down, using highly efficient nanocatalysts, as lots of pollutants consist merely of innocuous atoms arranged in non-innocuous ways. Polychlorinated biphenyls (PCBs), for example, just contain carbon, hydrogen, and chlorine.

(Ironically, living things—by accident—do much the same thing. We've all heard of the concentration of pollutants in the food chain, because biosystems preferentially absorb many pollutants. So we have a somewhat macabre "proof of concept" here as well. This bio-example also shows that the laws of thermodynamics do not make extracting low levels of pollutants energetically prohibitive, as is sometimes claimed by naive environmentalists.)

Yet other near-term (and potentially lucrative) environmental applications of nanostructures lie in energy generation and transmission. High temperature superconductors, for example, are not likely to be practical until atom-by-atom nanostructuring exists. (And this goes especially for room temperature superconductors; if they can be built at all, they'll be delicately nanostructured.) Cheap, efficient solar power collectors (photovoltaics, or maybe artificial photosynthesis) similarly are likely to require cheap nanostructured materials. A favorite item on my high-tech wish list is a solar-collector material that's measured out like bolts of cloth!

Nanocatalysts will also make industrial syntheses vastly more energy efficient, both because high temperatures won't be required, and because the syntheses can be much more specific. The spate of unwanted by-products, which are currently so costly in terms of purification and waste disposal, will be largely avoided—much as biological enzymes catalyze synthesis only of what's needed, and do so at room temperature.

Maybe we should give (say) tax credits for *not* using heat in industrial

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processes!

Dirt and Sewage: Resources of the Future. Of course, not all regulations are benevolent, and even reasonable regulations can be set up in counterproductive ways. (One egregious example is the regulations surrounding PCBs. In a fit of legislative hysteria back in the '70s, even the tiniest amounts of PCBs are heavily regulated, and actual samples of PCB-contaminated soils are all but impossible to get hold of. The predictable result, of course, is that very little work on PCB remediation has been done, and the problems are still as bad as when the legislation was passed.)

We could encourage non-thermal technologies even more, say, by giving tax breaks to non-virgin materials, or by making it much easier to reprocess (say) an old mine site rather than to begin a new one. Better yet would be additional incentives for using waste as resource: to process tailings heaps, waste dumps, slag piles, even sewage; or to mine landfills instead of virgin territory. And despite what you read in some of the "ecology" literature, waste as a feedstock is perfectly possible and perfectly reasonable.

Let's look at sewage first. The big problem with disposing of sewage and other biological waste (besides its potential infection hazard) is its "biological oxygen demand," or BOD. In other words, the stuff consumes oxygen—which leads to big problems if it's dumped into bodies of water containing oxygen-using aquatic life (e.g., fish).

BOD also means, though, that this "waste" contains free energy! Biowaste consists of chemically reduced carbon—i.e., carbon bound to hydrogen or to other carbon atoms. This means it can be oxidized to release energy—and bacteria do so, to get the energy to drive their metabolisms.

Now, reduced carbon is also one of those resources we're supposed to be in danger of running out of. Most fuels, to be sure, contain reduced carbon—oil, for example. But reduced carbon compounds are also important industrial feedstocks. One of the major uses of petroleum is for petrochemicals—plastics and their precursors, plus all manner of other chemicals and raw materials. In fact, people have wrung hands over the fact that we're *burning* all that oil, instead of saving it for industrial uses. An undergrad professor of mine, for example, talked of "C-C" (carbon-carbon) bonds as a resource back in the early '70s. (He—and I—didn't remember that biological systems —green plants—make C-C and C-H bonds out of CO_2 and sunlight all the time!)

For obviously, biomass contains reduced carbon. But rather than (say) growing new biomass for industrial use, why not use biowaste? Instead of dumping it, where its BOD adds to pollution problems, let's use those reduced carbon compounds for raw materials, for making fuels such as methanol or methane, or for making industrial chemicals. To first order, for example, sewage sludge and oil have similar compositions (sewage is richer in nitrogen). And conve-

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niently, a sewage-collection infrastructure is *already* in place, at least in the industrialized world.

Such developments are already happening, at least at an experimental level: several research groups are looking at using sewage sludge as a substrate for making industrial organic chemicals such as acetate. Other groups are looking at fermenting household waste into methane; for use in developing countries, initially, but the potential applications are obviously wide. In both cases, the experimenters are using conventional biotechnology, with specially selected bacteria, to ferment the sludge into the desired end products—an obvious first step, but hardly the last word.

Let's now look briefly at other nonconventional resources. One obvious objection to reprocessing old mine sites is that the metal we were extracting from the mine is now all gone. This isn't always true, though; generally there's still metal present but in currently uneconomic concentrations. Even if it's gone, though, other useful metals remain. Aluminum and iron, in particular, are present in nearly all rocks. Our present Al and Fe ores are nearly pure oxides or oxyhydroxides only because of the thermal paradigm.

But more than that: mine waste is nearly all silicates, and they may prove far more valuable as resources in the future than has been the case in the past.

Why? Again, current theoretical studies of nanomechanical systems have proposed diamond-like frameworks as the rigid structure to which everything else is attached, so that carbon is fundamentally the structural element. Now, diamond has some nice properties. The covalent carbon-carbon bonds in diamond are not only strong but very stiff, so they resist bending. Carbon is also fairly common, and it's obviously easy (at least conceptually) to bind organic ligands to.

But diamond's certainly not the only option. And it has disadvantages; you can't use it at high temperatures, for example, because it oxidizes. Silicates provide an alternative framework material, which (curiously) no one seems to be looking at. But such a use is foreshadowed by the many actual and potential uses of zeolites I've described. And even though the siloxy bond (-Si-O-Si-) in framework silicates is not so strong as the C-C bond in diamond, it's still strong and stiff. As zeolites show, it can support open frameworks just as diamond does. And it has one major advantage: unlike the C-C bond, it won't burn—no matter how hot the environment.

Silicates are also the most common compounds on our planet; the Earth is largely *made* of silicates. So there's hardly a problem with access to resources.

But even though most any pile of dirt becomes a resource, given a silicate nanotechnology, we probably don't want to dig up just any pile of dirt. Lots of places on the Earth have been disrupted already; why not use them first? The detritus from mining and smelting, for example: waste, tail-

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ings, and slag. "Waste" is the piles of non ore-bearing rock ("gangue") piled up at the mine itself. "Tailings" are the slimy crud, consisting mostly of extremely fine-grained clay minerals, that's left after crushing and grinding the ore to extract the ore minerals. And finally, "slag" is the glassy silicate left from pyrometallurgical processing—smelting.

But a silicate nanotechnology is really icing on the cake. Long before then, we'll have non-thermal extraction processes. Technology is already being driven that way anyway—and a major driver is environmental concerns.

ASSEMBLING ASSEMBLERS

How would you build nanostructured materials? There are several approaches, some very sophisticated, some less so. And as you'd expect, the most sophisticated approaches still lie beyond the state of the art.

Currently things like zeolites are made by "shake and bake": silica gels are spiked with other stuff, and the synthesis procedures simply consist of recipes for preparing and treating the gels. (One critical ingredient is large organic molecules, which act like templates around which particular silicate "building blocks" can crystallize.) Zeolite synthesis is thus another "black art"; we have little understanding atomistically, except in very general terms, of why silicates crystallize as they do, and we certainly have nothing like atomistic control of their crystallization.

And the syntheses yield tiny (micron-sized) zeolite crystals, which are added to a reaction vessel just like reagents. They end up used not so much as "sieves" but as selective absorbers. Even though a macroscopic, monocrystalline zeolite film or membrane would be exceedingly useful, so far we can't make one. (Or we can't cheaply, anyway.)

Similarly, the synthesis of organic polymers for organic membranes, ion exchange resins, and so forth could be summed up as "stir and hope." You end up with tangles of macropolymers and strands jumbled higgledy-piggledy. There's no control of the pore sizes between the fibers, or the structure of the working surfaces in contact with the solution. The active ligand sites aren't even necessarily exposed! Even more so than with silicates, too, organic synthesis is plagued by competing reactions. Lots of unwanted by-products always form, themselves to become a disposal and purification problem.

Micromachining may provide other manufacturing pathways, although this doesn't truly operate at the molecular scale, at least not yet. This is how computer chips are currently made: their surfaces are microetched, after a "resist" is laid down by UV microlithography, and new layers are then deposited (commonly by chemical vapor deposition, CVD). A more exotic technique is ion implantation, in which ions are slammed into the substrate, for example to "dope" it with new atoms. And other, similar techniques are under development. Obviously, though, although such fabrication is "micro," it's not "nano." There's still little control as

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to what's happening at molecular levels. But newer techniques may let us approach closer to those scales—and research toward continuing miniaturization of electronics is heading this way already.

Molecular self-organization, letting the molecules arrange themselves, is more sophisticated. You do this by arranging that the forces between the molecules tend to line them up the way you want. Conventional chemical synthesis, of course, already uses self-organization, but at a very low level: when a zeolite crystal precipitates from solution, for example, or when a vapor crystallizes onto a silicon chip surface. It would be nice to have a *lot* more control, though, and living systems provide a proof of concept. They assemble, routinely and reproducibly, very large and non-periodic molecular structures.

Of course, you *could* put something together atom by atom. An atomic force microscope (AFM) lets you pick up and manipulate individual atoms, at least under some circumstances. The problem is that macroscopic objects contain lots of atoms. *Lots* of atoms. Although you can move atoms individually with an AFM, it would take you a significant chunk of geologic time to build anything you could actually see. For this reason the assembly process must be automated, and it must be *fast*, which probably means that it must be carried out in parallel.

What's the answer? Drexler has proposed "molecular assemblers": nanomachines that themselves make nanomachines. He proposed using assemblers to build other assemblers, but that gets into the whole problem of designing and building complex nanomachines that could confront the infinite messiness of the real world. Instead, why not use such assemblers to make nano*structured* materials, the way the molecular machinery in a hair follicle spins out hair? Yes, such assemblers are nanomachines, but using them this way has a profound advantage over the "nanomechanical bugs" so often (and prematurely) envisaged as *the* nanotechnology. They remain inside a controlled environment, so they don't need to be so robust. They're shielded from the slings and arrows of the cold cruel world (to mix a metaphor badly). Since you can control the feedstock material they're getting, there's less chance of an oddball contaminant gumming up the works.

In addition, cranking out precisely nanostructured membranes, crystals, surfaces, and composites will give us practice in designing, making, and handling structures at the molecular level. It's a necessary first step before we can progress to the nanomechanical systems. You crawl before you walk. Let's first learn how to make intricate molecular structures that *don't* have lots of moving parts (and that aren't too sensitive to an atom being out of place here and there) before trying to build systems with moving parts.

And *someone's* going to make a couple of bucks at this, too.

WHO'LL DO IT? CONCLUSION

That leads to the last point: nano-

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structured materials are relatively cheap to get into, and they're getting cheaper all the time. So, with such low entry barriers there's lots of room for entrepreneurs. You can buy an AFM for around $100 grand, last time I looked, for example, and of course organic chemicals—the building blocks of polymers, membranes, composites, and whatever, are cheap. So are the precursors of silicate gels, for that matter.

And for the applications that have environmental applications (ion exchange resins, zeolites, catalysts, semipermeable membranes, etc.), there's a few trillion dollars to be made in the interim. The Intels, Apple Computers, Microsofts, and Genentechs of the early 21st century will lie in such nanostructured materials.

We'll see a paradigm shift, too. Old-time miners are now complaining about the increasing difficulty of mining; about how environmental regulations and "wilderness lockups" are destroying their industry. But they've no sense that their industry may be becoming obsolete, and their efforts to preserve it, at least in its present form, are misdirected and probably futile. (And yes, I've worked in the resource business for a number of years, so don't tell me I don't know what I'm talking about.)

The new fortunes to be made in the resource business will probably be made by entrepreneurs who bypass traditional mining, who come out of some hitherto unrelated field such as materials science or computing. (Few buggy-whip manufacturers got into the automobile industry, either.)

And last, these stepping stones to nanotechnology provide more than a way for some bright and ambitious people to make megabucks. They even provide more than a way to clean up the planet. They're perhaps the most hopeful thing to happen since the collapse of the Soviet Union. For they can provide a realistic way to give everyone in the world an affluent lifestyle. Environmentalists have commonly said that worldwide affluence is impossible, and some have even proposed curbing the "teeming masses"; genocide in the guise of biological necessity. (This is counterproductive, not to mention politically naive, to say the least. And where have we heard that "biological necessity" excuse before?)

But they're wrong. It's merely impossible for everyone to be affluent with the glorifications of 19th century technology we use now. That's not to say it's impossible.

And, as many people have pointed out, affluence is the ultimate cure for the population explosion. It is the reason that the birthrates in the industrialized countries are below the replacement level right now.

Yes, the future is hopeful. ■

> There is something wrong with everything that is popular.
>
> —Charles Fort

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Jayge Carr

ROOTS AND FORBIDDEN FRUIT

There's always been a fundamental gap between nomadic and settled folk—and with interstellar *nomads, the gap gapes even wider. . . .*

Illustration by Janet Aulisio Dannheiser

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He had had the stars, and wandering; now he only wanted to sink his roots into his chosen section of enduring earth.

The virgin soil parted beneath Sergei's plow like a magnetic Stiktite closure unseaming. The weary neohorses plodded on as he guided them in the precise furrows.

Once, in another life, he had berthed shuttles, piloted starships, commanded men with the same fiercely determined competence.

At the edge of the field he saw Elder Mihael Werner, standing with arms crossed over his chest and wooden-soled boots firmly planted, as ominous and inflexible as the angel with the flaming sword from the ancient writings that had whiled away so many of the long starry hours.

Sergei cursed under his breath. One at a time, he wiped his suddenly sweaty hands on his coarse linsey-woolsey breeches.

The light was dimming into a spectacular sunset, it was time to quit anyway. At the end of the furrow, he headed for the crude barn, greeting the Elder who fell into step beside him.

"The Creator's peace be on you, too, Goodman Andersen," Mihael Werner replied heavily, thus setting off an alarm in Sergei's head. Normally, Werner called him "Friend Andersen" or even "Friend Sergei." When he was especially pleased he even remembered that they were related by marriage, and Sergei became "Cousin Sergei." The only worse sign than the formal "Goodman" was if he became again "Captain Andersen."

It was Captain Andersen business nonetheless.

Sergei sleeved sweat off his forehead with an arm that weighed heavier than neutron-star-core despite the less than T-standard gravity. But the pain, the tiredness, was good. It cut him off, day by day, from that rootless constant wandering that had once been his life. It was the price, part of the price, and he paid it gladly, day by day, over and over. "I've spoken to the crew, as you asked me to. Several times. But I'm no longer the captain here, my ship is an orbiting hulk. If the crew had worked together before, developed an *esprit de corps,* I'd have more influence. But you know how hard you had to recruit, one from a ship here, another from a service there. The voyage was long, but the crew rotated their duties. Many of them slept almost as much as you passengers did. I've some authority, and I've used it. But there are other officers, even some who were once captains, or close to it, and when crew have a choice, they go with those views they like better. Whose orders, or suggestions, or whatever, they agree with."

"I understand." The elder nodded. (It was a title, not a literal description. Physiologically, he was roughly Sergei's age, some fifty or so T-standard years. Here it was early middle age; on a high-tech world, the bare beginning of prime manhood.) "And I believe you've tried your hardest, and not just because you married my cousin, either." He grinned suddenly, the thick hair surrounding his mouth parting to reveal large white teeth.

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"There are those among us who forget that Goodman Rossetti was once a planetary chief executive."

"He was? But he's not even on the Council."

"No, he isn't." The elder nodded again, his hands busy helping with the unharnessing of the neohorses. Already, with his flowing beard and hair, his homespun clothing and handmade shoes, he looked like an illustration out of a textbook: Neolithic Man. Sergei, in contrast, was permanently depilatoried, all over; he was well aware that his smooth gleaming skull and forever beardless chin were just one more mark of his difference.

Sergei had long since dismissed Goodman Rossetti as a self-important little strutter; he returned to the important problem. "Surely you must have anticipated the crew's reaction? You knew they could never go back. The relativistic passage of time on the long voyage has cut them—cut us all—off from whatever there was to go back to."

"Well, lad." Sergei had put on the yoke holding the four water buckets, the elder had adjusted it fractionally on his shoulders. "We did and we didn't, so to speak. They signed the agreement, after all."

"I did, for them," Sergei reminded. "They only signed standard length-of-voyage contracts." He was thankful to get out of the small barn, with its closeness and acrid tang of human and animal sweat, overlaid with the riper richness of dung, and the pungent hay. But having real roots made the stenches, made anything, worthwhile.

"Humph." Elder Werner snorted. "Howsoever, we didn't anticipate their setting up a machine colony on our very doorsteps. We thought we would gently and lovingly bring them to our beliefs. Instead. . . ."

"As we've all seen," Sergei said dryly, nodding. "You underestimated their ingenuity at adapting the ship's equipment to use down here. You assumed that without technology they'd be forced to come to you to learn the old ways to survive. You thought—"

"No, you wrong us there, Friend Andersen. We knew that there would be some usage, though we expected a sense of honor would minimize it. We hoped, since we are many and they few, that over a period of time some of them would recognize their errors, that we would grow and they would dwindle; that as their machines failed them, we would be here, ready, to show them the true path."

Sergei sighed, as he picked his way, head down, over the muddy, trodden track to the small brook. "Your time scale's off, that's all, Elder Werner. Think in terms of generations, instead of the months we've been here, and you'll probably be right." He knelt, unhooked the buckets, began to fill them one by one from the clear running water.

"Yet in all those months—" the elder knelt beside him on the slippery rocks, filled a bucket and hooked it back on the yoke, "—you are the only one of the crew to join us, wholeheartedly. The only one, and you were with us from the beginning."

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His eyes met Sergei's and flicked away. He muttered softly, and Sergei heard, though he was unsure if the elder meant him to or not. "There are always the foolish, foolish youngsters."

Sergei stood, his shoulders weighed down by the filled buckets. "Ah. Now you want to know why I did it, because you hope it will help you with the others."

The elder nodded.

Sergei chewed his lip, and plodded back up the path, picking his way gingerly, balancing the weight, trying to think how he could explain to this groundling the *why*.

With four hands instead of two the evening chores went quickly, but didn't bring him any closer to the words he needed. Finally he tried to explain, haltingly, what it was like to see many worlds and many times, to a man who had known, up to his single voyage, only one world and one time. How it felt, as your life marched—or staggered—on, realizing how little truly endured. The way always-moving-on and never-a-real-roots-down-home grated and galled, a deeper and deeper unhealing psychic wound. A wound (Sergei kept this part to himself) that, finally, led to the conclusion that no price was too high to pay for its healing.

"But there's more than the rootlessness." Sergei flung the traces up onto their hook so fiercely that the hard leather creaked in protest. "Alienation. Contempt. Rejection by the planet dwellers." To watch a dozen worlds slowly diverging, each in its different but mechanized path, each lived on by humans slowly adapting to the physical realities of their worlds, those adaptations —those *changes*—plain to the star-traveling visitor. Each world convinced it and it alone was the norm, the gradual alterations of centuries invisible to eyes that would not see. It was the starfliers who stayed the same, and by so doing became more and more different, who had "changed" into aliens, become pariahs, outcasts.

Grooming the neohorses with long, patient strokes, their warm sides smooth under his fingers, their whuffles of contentment a soft counterpoint to his words, he tried to explain the growing hate and fear more and more of the planet-bred were developing for the star-travelers (here, again he didn't say it, repeated in miniature in this conflict between the colonists and the crew) and its effects on himself and the others. Nor did he explain—he and many others had tried, and the non-technology-oriented never understood—one of the other main causes of that hate and fear, the gift of relativistic time. A starfarer could spend a year of his own physiological time traveling at high speeds from world to world, and return, seemingly unaged, to find fifty years had passed on the slow-spinning worlds, and those he knew aged or dead.

Nor did he mention the basis of truth in the accusations of mutant: the starfarers, exposed to radiation on their long voyages, did produce a high proportion of deviates, higher still if starfarer bred to starfarer. (And,

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to world-bound eyes, worse than the outright cripples and deformed, were the tiny minority who enjoyed improvements, blessed with extra gifts of mind or body.) Instead he spoke of reactions to hate and fear, and the careless actions or deliberate cruelties of some who knew that decades if not centuries must pass before they returned to a particular world.

"Action and reaction," Sergei finished, kneeling to splash the last bit of warm water in one of the buckets onto his own face and shoulders. "Beware the stranger. But even your brother becomes a stranger, if you have changed and he has not. Anger breeds anger, distrust distrust. Fear becomes fury, prejudice violence. Until . . . think, Elder. You yourself regard us as all alike, because, in your heart, you think of us as *different,* and lump us all together."

"Nay, now, Friend Sergei!"

"I'm not blaming you, Elder." A bit of rough, clean toweling hung on a hook, and he used it to dry his face and hands. "It's only human nature to think so. But—for example, I'm service-bred. I've known no other life, though I've seen countless societies on countless worlds. But many of the crew would have been planet-bred recruits, from the computer alone knows how many different worlds or ways of life. Even if two recruits came from the very same city on the very same world, generations of world time, with all the changes that implies, could separate them, if they came aboard on different voyages. I know why I came here, I wanted to come, I wanted to be part of what you're building here. I've had time, in those long watches I've spent, to do plenty of thinking—"

With only a thin skin of faked normality to separate you from the endless night without; and sometimes, in those weary hours, there's the observation blister, forbidden except for necessary sightings. But, ah! The distorted wonder of those surrounding immensities. But not even the forbidden glory was enough to compensate for the loneliness, the alienation, the separation from the rest of humanity, the sense that all your accomplishments were melting away like a sand castle before the rushing tide of time. . . .

"—Time, and wandering," Sergei went on, after a long breath—or ten. "The ship, a ship, and the crews, but never anything lasting, never anything permanent, never a feeling of being a part of, instead of an outsider. I was looking for you, or a people like you, long before you started looking for a captain like me."

"Ah." The grizzled head nodded. "I think I see. But the others?"

Sergei shrugged. "Running away, I'd guess, instead of running toward."

The elder was chewing a very bitter cud. "So you suggest?"

"Let me think on it. In the meantime. I'll try to talk to them again."

Elder Werner's scowl grew even sourer, then he took a deep breath and his face smoothed out. "Ah, then, Friend Sergei, you're a lucky man, you are. She's her mother's touch with the stew pot, that she has. We needn't worry about your Marya, need we, then? She's settled down."

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Marya lifted the tanned hide that was the only door to the single turf-roofed subterranean room that would someday be their cellar but was now their living quarters. "Sergei, I was just going to call—Elder Werner!" She sketched a quick curtsy. "I didn't know—"

"Nay, lass, I but dropped by to wish you good day. Good as it smells, I must be on my way or Ella'll worry. Besides—" He pinched her cheek genially. "I'd not take away from that second you're eating for."

"Elder Werner!" She stamped her foot. "How did you know?" She looked down, smoothing her skirt over her still flat midriff. "It doesn't show."

He grinned broader. "Eight my Ella's had, and the ninth coming. Do you think, child, I don't know that look on a woman's face when I see it?" He clapped Sergei's back. "Congratulations, Cousin Sergei, to the both of you. Oh, aye." He chuckled. "Settled down all right. Ah!" A loud, long sniff. "If I didn't know Ella was waiting and keeping mine hot. . . . "

"Just a quick taste, then, Elder Werner," Marya coaxed, "to be sure your nose wasn't playing tricks on a hungry man?"

He was ready to leave, had mounted his neohorse and said goodbye to Marya when he remembered one last item. "Friend Sergei, there's something else I'd have you do if you would."

"If I can."

"Get your wife to talk to her sister Innis. They're much alike, and very close, and mayhap your Marya's word will help. And young Innis—I like her, you know. She's a gay little spirit, she brightens the room she's in. But she's young, and foolish, and my liking won't help her a bit if she treads too close to disobedience."

But when Sergei passed this on to Marya, to his surprise she pursed her lips over the sweater she was knitting and said, "There's nothing I can do."

"Because you don't know what's the matter?"

"Because I do know what's the matter, and there's nothing I can do. There's only one of you, you see."

"You're not going to tell me young Innis thinks she's in love with—she's just a child!"

She shook her head, her lips tight. "You wouldn't understand." And that was all he could get out of her.

The busy days passed. Fall, winter. Sergei could only hope that the Council's patience was holding.

Oddly, it was Marya who lost her patience. One winter evening, she hurled the spindle she was using across the room. Sergei looked up from the broom he was painstakingly carving from a single thick branch, by shaving layer after layer of thin blades up to a predetermined point. "What's wrong, darling?"

"Everything, that's what! This is *stupid!* It takes forever to spin any yarn on this ridiculous spindle. There must be a better way!"

"Not by the agreement," he said mildly, solicitous of her pregnancy. "No machines. We can't use anything we can't reproduce ourselves. So—"

"I'm not talking about machines,"

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she grumbled. "Though when I think of all the lovely machines we heard of back home (not that they allowed *us* to use them, either!) but machines that could produce yards and yards of lovely cloth in the time it takes me to spin a teensy thread, well, I could just cry, or—or scream. *But*—" She stared at her husband. "There must have been *something* in the middle. Something more efficient than this stupid, slow, rotten spindle. Something that could be made by hand, but. . . ." Her voice trailed off, but her lash-shaded hazel eyes remained fixed on her husband.

He wanted to please her, and he couldn't see the wrong, as long as it was something that could be made, with whatever effort, by hand. He had kept a Link with the giant ship's computer, which had been left, just in case, on stand-by. So he got a diagram for a spinning wheel.

A foot-pedal powered loom.

A device with weights that wound up and turned the spit.

He was thinking about the small, wind-powered millstone he was making to replace her hand quern while he tied up his horse on his weekly trip to town—and saw Marya's sister Innis on the punishment stool.

For a second he almost thought it was Marya there. The sisters looked much alike, as though Innis were a younger, prettier, but somehow less formed copy of her sister.

He walked slowly toward her.

Stooling wasn't meant to be a physical punishment. The "stool" had arms and a high back, comfortable padding, even a canopy to keep off the Sun's heat or the rain. Instead, stooling was a public portrayal of guilt; it was the isolation, the carefully avoided stares, the knowledge of universal condemnation that formed the penalty.

It was custom, when one of the community was stooled, that each passerby stop and offer to the sitter a heartfelt wish along the lines of, "May your repentance come easily," or "The Creator welcomes the blackest of sinners, if that sinner regrets and repents." Innis flicked him a glance as he approached, his wooden-soled boots making a sucking sound as he pulled them out of the mud. Dirty tear streaks runneled down her round, still childish face, but the swollen, reddened gray eyes were sullenly defiant.

"Why, Innis?" he asked softly.

"I won't marry him," she replied. "So they call me disobedient."

"Young Rossetti?"

She nodded, eyes as downcast as her sternest critic could wish. Only Sergei could see the repressed anger in the full childishly pouted lips.

"Someone else?" he asked softly, thinking that if there were, as Marya's husband, he might have some influence.

She shook her head, biting her lip.

"Then why not Rossetti? He's a handsome enough youngster, hard working, excellent prospects."

"*They* chose him, not me. I don't even like him." Her mouth made a spitting gesture. "Even if I did, I don't want to get married, not yet anyway. And never to him; he'll beat me."

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"What? How—"

"His father beats his mother." She spoke with the simple shrewdness otherwise unintelligent people sometimes display. "I've heard her scream. Pietro's very like his father."

"They can't make you marry against your will, wait and see. There'll be someone you want to marry —or—" She was looking at him just as Marya had, when she refused to discuss Innis. It was a look that reminded him that these people had been stubbornly living their way for generations, that they had developed subtleties that he, the outsider, could never understand. In a flash of insight, he realized that their world had been as eager to get rid of them, as they had been to leave it. None of which solved Innis's problem.

Elder Werner dismissed all his arguments with: "It's settled. Both fathers agree. She could do far worse, you know."

"But she's so young. Wouldn't it be better to wait?"

"You think all our girls marry as late as your Marya? No, no. Someone would have snapped her up long since, if her mother hadn't been ill and her presence needed. But Goodwife Waters has rejoined the Creator, and Goodman Waters's year of mourning is over and he is eager to remarry. As soon as young Innis is safely settled; it's not good to have two females trying to run the same household, you understand. And that's final." He stood on his porch, the bag of seed he had been closing left untended for the moment so he could give all his attention to Sergei, his gaze kept carefully away from the green where Innis sat in the stool. (All the council had farms within easy walk or ride of town, and homes by the small square, so that they were available for town business.)

"But—"

"No. No more, Goodman Andersen." His pipe pointed suddenly at Sergei, an accusing finger, Werner himself suddenly as straight as Gabriel about to blow his trumpet. "I thought you would understand, but I see you don't. I blamed you, and I was wrong, so I'll speak plainly, for your sake and the colony's."

"Was I wrong to speak out for Innis? She's Marya's sister, after all."

"Innis? She's but a girl. Bridal nerves is all that ails her, a young girl's fancies. She'll soon enough see that older and wiser heads know best. No. 'Tis you who are walking a dangerous road. Goodman Andersen—Friend Sergei—you must cease this making of new tools!"

Sergei's mouth dropped open and hung foolishly.

"The wheel." Werner ticked them off on his fingers. "The loom. The spit."

"But—but—but—they're handmade. Within the agreement. Half a dozen of the women already have copies of Marya's wheel."

"Oh, aye. More than that, I'd say. More than that. While those who don't are nagging their husbands or fathers to make them one, as soon as may be."

"I don't understand." Automatically he bent down, ran the twine

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draw through the last two pairs of holes in the top of the bag and knotted off. "They're handmade, and soon every woman will have one, so where's the problem?"

Even this late in the day, the town thrummed with activity. Down to the smallest child, all had chores. Werner himself had been loading a wagon with seed for his farm. Now, as if to emphasize what came next, or perhaps to think out exactly how he wanted to say it, he paused to sling two more heavy bags up onto the wagon. Without being asked, Sergei heaved the third and last bag, the one he had knotted closed, from the ground onto the top of the heap.

Werner shook his head, slowly. "Aye." A sigh. "You don't understand. I'll be patient with you, then. You know—with your mind, with your intellect—why we came here, why we fled the soulless Sodom and Gomorrah machine world that bred us. But your heart is blind. We came here—" the pipe came out of his mouth, its stem pointing at him in emphasis, "—to live—Our—Own—Way. To live on the land, and with the land, but never, ever, *never off* the land."

"What harm can a spinning wheel do?"

"None if you stopped with the wheel. But you didn't, did you? If we let it, it won't stop until we're back to the world we came from, with the soulless machines both our slaves and our masters, and the children ruined before they can scarce draw breath. No. You must *stop!* Understand! Stop—or you will be *stopped.*"

Sergei nodded, slowly. "I understand."

"Do you? Good. You're my friend, and my cousin by marriage. But you've been breaking our laws. It was ignorance. As long as it doesn't happen again, we'll say no more about it. But don't do it again, Friend Sergei. Because lawbreakers will be *punished.*"

The baby was born two days later, and they named him Schemuel, after Marya's father. (Sergei hadn't the vaguest idea who his father had been.) The birth was hard, and both Marya and Schemuel were weak and ill, after. Sergei spent days that stretched into weeks, going from one patient to the other, staying up nights with the sick woman, the fretful infant, his work and his land neglected. Until one day he realized, horrified, that it was spring planting time, and past. So he called the computer again, and got diagrams for a simple seed drill, that harried and readied the soil and planted, all in one operation.

When his seed was safely planted, he took the drill apart again, and said nothing.

But he didn't want to upset Marya with what Elder Werner had said, so he simply vowed to himself that the seed drill would be the end of it.

When Marya was well enough, they entered fully in the life of the colony, driving kilometers in the jolting wagon to attend a barn-raising, join a haying crew, or whatever.

Sergei had long since discarded his synthetics for Marya's home-spuns, and her clever hands had made him several hats, knitted for winter,

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brimmed straw for summer, to hide the smooth bald head. Nonetheless, every so often when he approached, talk would stop abruptly, and begin again on a different note. He shrugged it off. Despite his marriage, he was still the outsider, the alien.

The rest of the crew remained the proverbial thorn-in-the-side. They had finally drifted into a commune existence, growing just enough to live on, wearing synthetics, using the refrigerators, the tractors, the other machines despite the agreement and his own urgings.

His one minor victory had been the clothing.

Pilot Jessamine Chang had spoken for all the crew when she said, "Captain, we're not savages, we're not primitives, and we don't intend to live like them. We've the equipment, and the parts and the knowledge to keep it running indefinitely. Why should we waste our time doing things by hand that can be done faster and easier by machine?"

He felt out of place, in this foamed synthetic room that was so similar to those he had spent all his life in. But that was before, and he understood how the colonists would feel about the unnaturalness of the smooth, softly glowing pastel walls. They were *wrong,* and he had to repress an urge to bolt for the clean outdoors. "This is *their* world," he said bluntly.

She shrugged. "Big enough for all of us, I'd say."

He laughed at that. "Never in history. Look—" He spread his hands in a placating gesture. "They are the majority, the crew the minority. What harm can it do to respect their customs, whenever you go among them? If you don't want to do it yourselves, grow enough extra crops to trade for the handmade cloth, and wear it whenever you go off the commune. What you do in private is your own business. Just don't rub your differences in their faces."

"We'll not turn peasant." The scorn in her voice added: *As you did.*

"You don't have to. Just do as the Romans do—when in Rome."

"Act the hypocrite, you mean."

"Respect their beliefs, that's all. Don't go against their customs."

"Fine for you to say," she snapped. "You're a man. That Marya of yours knew exactly what she was about. Did you ever notice, it's Good*man* and Good*wife,* and no term at all for an adult, unmarried woman? Look at their so-called government, one vote for each married couple, or widower—but not widow. What about all the fuss now, because they want to chain that unwilling child to a man she despises. No, Sergei. Thank you, but—no, thank you!"

It didn't surprise him that the commune had heard about Innis. It had, after all, been the talk of the village for months. His mouth tightened. He, like Jessamine, disapproved of what was happening; though he couldn't help wondering if he'd have felt so strongly against it if it had been someone else, not a child who was so like Marya. But he couldn't explain it to Jessamine, when he couldn't understand himself, so he merely said, "Primitive people tend to be patriarchal, after all."

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"Myth," she snapped. "Human nature is what it is. Humans need to have someone to look down on, someone to be the universal servant. In a technological world, the machines serve. But in primitive ones it's any minority, sex or race, skin color or religion, that can be set off and downtrodden. Your colonists are speeding toward a true two-class-by-sex society as fast as their weak-kneed idiot women will let them. They're the true hypocrites, the women *and* the men. Like—they made a fuss about your spinning wheel, didn't they? But not a word about the seed-drill. Except, you wait and see, next year every man'll have one."

"The seed-drill? How did you hear—"

"Marya told me."

"Oh." He relaxed. "Not to worry then. I wasn't supposed to make it. But there won't be any more . . . oversights. I won't; and you mustn't. These people *believe*. You're offending their beliefs. Think about it, Jess. What harm can it do to get a few sets of homespuns, and wear them whenever you visit off the commune?"

"You always could argue a navigator into orbiting through the Sun. No, I suppose it wouldn't do any harm, Sergei; but it still seems hypocritical."

"Try . . . good manners toward your hosts."

She laughed, but a space-crew used to world after world of strange customs, could understand the value of not offending those customs.

As he left he discovered one more reason for her personal alienation. She ran a casual hand down his back, and the constant ache that had been part of him ever since he had heaved a too-heavy burden several days before disappeared abruptly.

He whirled, and she said simply, "Pinched nerve, Captain. I fixed it."

"You—"

"They wouldn't have signed me on if they knew. They have the mudsider prejudices." Her ice-blue eyes were very bleak suddenly. "Like my own world . . . but you won't say anything, will you, Captain?"

He shook his head. "But the service. . . . "

"Yes, they would have *used* my talent. But I wanted to be a pilot. You, of all people, should understand wanting."

They weren't fools, the crew, and they had had experience with mudsiders, so they took his advice, bartered for the homespuns, and made an effort to wear them off the commune.

It was too late, anyway.

They came, twenty or more grim village males, at noon a few days after harvest, so that the fields were still rich with shorn stalks, the very air sweet with scent and dust of the harvested grain. Elder Werner spoke first, the Sun striking gleams of the red it had once been off his gray hair. "I'm sorry, Captain Andersen. But —you cannot stay."

He stood before the turf-roofed hole that was his home, his wife trembling beside him. Behind the men he had known as friends and neighbors, the fields he had made his by his labor spread out, greenly alive, infinitely precious. "I don't under-

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stand." This world was free of large predators; he had no weapon but an ax and a serviceable knife.

"We're purifying the land, Captain," Werner spoke sadly. "The machines and slaves of the machines must go. You are contaminated, you—and yours—must go, too."

"Go? Me and—the crew!" He couldn't imagine the disdainful crew surrendering to what they would consider a mob of primitives. The bright Sun touched the crowd with red. "You killed them! Creator, I—"

"Killers you think us!" The elder strode to stand a hands-breath in front of him, glaring from angry eyes. "Though for what they did, we had the right. But there are other ways, easier ways." He smiled suddenly. "Dependence on machines can be a —vulnerability. They're all fine, Captain, if a little . . . disconcerted. But—this has only proved they can't stay. They must go away, far, far away. And you with them."

"Why, Cousin Werner?" Marya made her appeal. "What's happened. Why—"

He glanced back at the silent mob. In the forefront were the Rossettis, father and son. Sergei followed his glance and Rossetti smiled at him, a furious, gloating snarl. "Innis," said Werner, "ran, and the commune took her in."

"Innis," from Marya. "Is she—did you—did they. . . ."

"She's safe enough with them, and better so. You may thank me for this, that she'll stay with those she's chosen, and not be brought back for whatever punishment Goodman Rossetti would demand."

Sergei put his arm around Marya. "You're right," he announced loudly. "Far away is the only solution. But—why exile me and Marya with them? Haven't I lived with you, worked with you, married one of you? Look—" He held up his hands, roughened by callouses, scarred by broken, healed blisters. "Look," he repeated, "the hands of honest toil, like yours. My fields there, where you helped me harvest my crops just days ago, as I helped you with yours. My house—" He gestured back. "—no better than yours and worse than some. But it was what I could do, I made it, myself. Go inside, clothing, furniture, everything, all handmade, by me or Marya. Whatever I was once, I'm one of you now. I. . . ."

Smiling gently, Werner reached into Sergei's pocket and drew out the computer Link. "All right, If that's what it takes, I'll destroy the Link, here and now, in front of you all."

There was a sigh from the crowd, and then silence, broken only by the contented noise of Schemuel inside, five months old, playing with a carved wooden rattle. Abruptly, the rattling stopped with a thud, as the rattle dropped, followed by a loud wail of dismay.

"Do it," Werner ordered. "Destroy the heretic machine."

Without another word, almost in rhythm to the wails of his son, Sergei dropped the Link to the hard-trodden ground and stamped its delicate sophistication to a mass of crushed components with his heavy boot.

Werner stuck out his hand. "Wel-

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come, brother."

In a daze, Sergei shook the proferred hand, and then, responding to the chorus of smiles of the people crowding around (he didn't even notice the Rossettis's quiet retreat), Sergei started laughing, softly, triumphantly—helplessly.

From inside, even over the chorus of laughing congratulations, came the contented rattle of the simple toy. "Fetch the babe, someone," the elder called over the noise. "He deserves to join the celebration." Marya made a move, but she was in the center of the crush. "Nay, then—" Werner smiled at her. "There's men that can carry a babe, eh, cousin?"

"Where are you sending the crew?" Remnants of loyalty made Sergei ask. "That isolated Australoid continent we mapped? It's the farthest, but the shuttle could make it easily enough."

"Nay." The elder had to raise his voice to be heard. "They would live with machines—ye sure carved that rattle loud, cousin!—let them live with their machines. They're going back aboard the star-voyager."

"But—" Sergei frowned.

"They've no cargo as large as she brought here, but the living quarters are still intact. They've all that they brought down with them, 'twill be enough. They wanted to live with machines, so let it be."

"Up in orbit—endlessly circling?"

"Nay, yon ship's a star-voyager, the engines still work, so let her travel again, as soon as she's loaded. They've agreed already." He winked. "We've put away machines, but there are those among us who can use them. We've kept the small shuttle, yet. It could be programmed to smash into the mother ship. They'll not linger."

"No." Sergei shook his head, thinking of how far a man could go, in his fanaticism. But it was the only way. As long as the machine culture was there, available. Like himself and the Link. As long as it was there. . . . "But worlds like this are rare; they may not be able to find another."

Werner shrugged. "Then they can go back, to the machine worlds they love."

"No, we came so far to get here, the time dilation effect—" He shuddered, imagining a ship of eternal voyagers, always searching, never finding, cut off from the worlds they visit not by twenty or fifty years, but by hundreds. Becoming more and more desperate. . . . As his voice trailed off, he realized that the crowd around had thinned, that the happy hum had died away, that frowns had replaced some of the smiles. In the silence, the rattle sounded even louder.

Someone twitched the elder's sleeve and whispered in his ear. As he listened, his face grew fierce. "Inside," was all he said, and wondering, they crowded through the crude opening.

There was a half-circle with the cradle at its center, a wide arc, no man closer than a couple of meters. Sergei, Marya, and Werner worked their way through the thin line . . . and stopped. And stared.

"You must go," the elder said finally. "Your machines betrayed you, Captain. You ate of the forbidden fruit, now you must pay the penalty."

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More prosaically: "We slept the voyage away, well protected. You did not. We can't take chances with our children's children. I'm sorry—Sergei."

In the cradle, Sergei's son lay, contentedly sucking his thumb, and on the floor, at least half a meter away from the nearest chubby fist, his rattle shook—and shook—and shook. ■

IN TIMES TO COME

Our December cover is a "standalone," and a first *Analog* appearance by Polish artist Wojtek Siudmak. The lead story is Grey Rollins's novella "Evolution," which is about just what the title implies, though not everyone involved is eager to admit that. You've met Grey's lunar colony before, if you've been reading *Analog* regularly of late; if so, you'll recognize that it, like any child out on its own, tends to develop in directions of its own. The trouble is that most folks like to think of themselves as the *pinnacle* of evolution, but few are eager to participate in it as an ongoing process. "Survival of the fittest" implies selective pressures, and if civilization has eliminated a lot of the old ones, it just may develop a few new ones. . . .

Mark S. Lesney, Ph. D., has a fact article on "Cybernetics: The Biology of Artificial Intelligence and Artificial Life." Until recently most people might have taken "artificial life" to mean something like creating axolotls from scratch, but certain kinds of computer research have given it a whole new meaning which is not likely to go away.

Rounding out the issue will be a variety of stories by G. David Nordley, Arlan Andrews, Jerry Oltion, Bud Sparhawk, and David Bischoff. One or two of them might look like fantasy at first glance, but be assured that the ones most likely to give that impression have all too real roots in science and technology!

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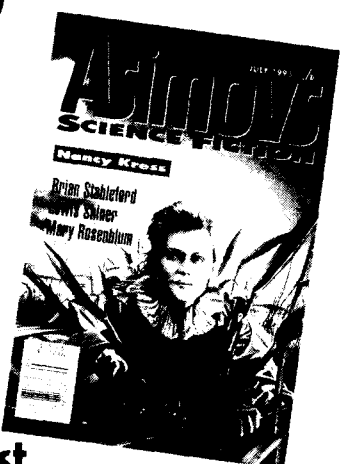

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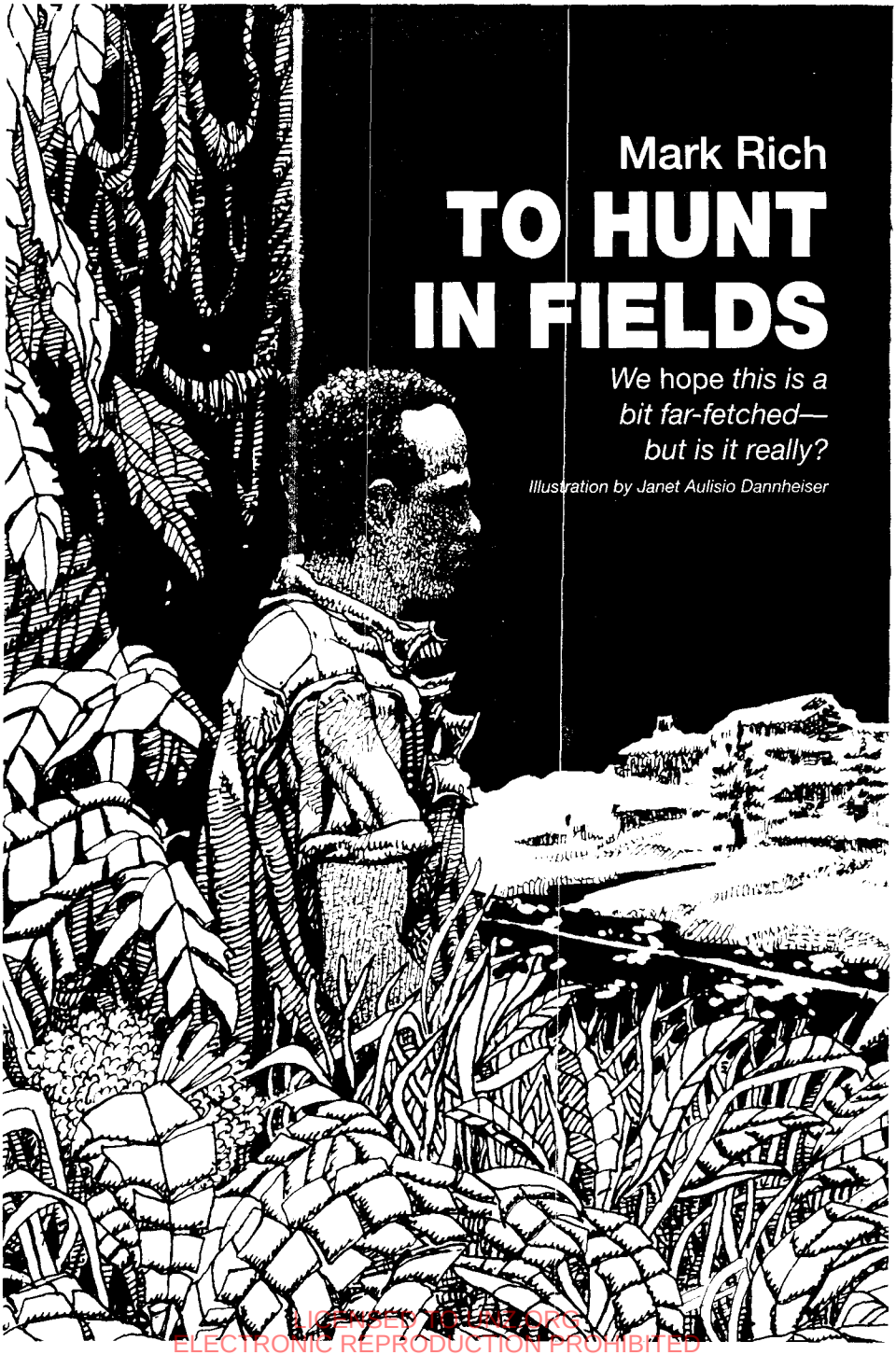

Mark Rich

TO HUNT IN FIELDS

We hope this is a bit far-fetched—but is it really?

Illustration by Janet Aulisio Dannheiser

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"Better to hunt in fields for
health unbought
Than fee the doctor for a
nauseous draught."
—Dryden

"Snow," Jim Malick said in wonder, shaking his head as he climbed in the cab.

The driver grinned at Jim via the mirror, white teeth bright against a face as dark as his own.

"What do you mean, 'snow'?" the driver said, with a chuckle in his voice. "As if we haven't seen snow two months going. Where you been?"

"Belize."

"Belize. That's down south a ways."

"Long ways," said Jim, feeling the miles in his muscles. His head ached after having subsisted on the closed, stuffy air of the airplane cabin. "Three-oh-four Woodbine Drive," he said after checking the note from the Exchange.

"Three-oh-four. We're on our way," the driver said. "What you doing there, down in Belize? Not getting weather like this, I guess."

"I was with C.A. Exchange. A little more than a year, I was down there," Jim said, settling back against cold vinyl. "Helping build up an ag co-op, a farming kind of thing."

"Yeah? Farming what?"

"Tree farms. Growing trees for bark. Medicine. For other things, too."

"No kidding." The car rode smoothly over snow which had accumulated to a depth of a few inches.

Though Jim's tennis shoes had kept his feet dry enough, he could have wished for warmer clothing.

"I was guessing you were just back from somewhere," said the driver, "just looking at your clothes."

"Guess I wasn't thinking what I was doing. A year away, and I forget what cold feels like."

"Guess so. Don't you get sick, now. Bundle up when you get home."

At 304 Woodbine, Jim paid the driver, hefted his bag, and hurried into the lobby of the apartment complex. C.A. Exchange had arranged that his things be taken out of storage and a room be reserved. After a hot shower he dug into his boxes of clothing, pulling out jacket, scarf, gloves, hat, thick socks and boots. He felt a catch at the back of his throat—an odd feeling, after so long without suffering anything resembling the common cold. The worst problem he had encountered in Belize, besides a couple cases of worms, had involved a scrape with poisonwood. The welts on his skin had felt even worse than they looked.

Some chicken soup would be good, he thought. His thoughts went to Millay's Diner, down on Fourth. He decided to touch base at the Painesville food co-op first, though. While he needed to get in touch with Dean Hegerman and others at the university, that could wait until tomorrow. Checking in at the co-op would help him feel like he was home. He had friends he wanted to see there, especially Vicki.

Vicki Corona had worked so hard at building the co-op out of its one-room beginnings that she qualified as the heartbeat, if not the heart-throb,

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of the little store. Tough mind and gentle heart, as King said. Without her the town would have been a lot poorer. For that matter, without her, Jim's first year at the university in the newly created position of Professor of Ethnoagriculture would have passed much less eventfully, and much less pleasurably. They had become good friends in pinches of time squeezed out of two tight schedules.

Jim had felt insecure about his position at the university, and moreover had been preoccupied by the heavy load of committee work typical of freshman professors. He had paid his dues to the university, taken with a grain of salt the assurance of Dean Hegerman that he was firmly on tenure track, and accepted the position in C.A. Exchange with something of a breath of relief, for all that it meant it would take him all the longer to feel at home in Painesville.

Home. It felt like it, in some ways. He remembered the streets, the white pines that shook their long needles in the winter wind, and the bare arms of dormant maple and birch. He walked up the street and onto the next block, trying to decide if he loved the feeling of cold on his face and in his nostrils, or if it came as too much of a shock. Only the day before he had been comfortable in light clothing in Belmopan, sipping a beer, nibbling peppers, and thinking back on the work of more than a year, now at its end, with not a little sadness.

Had he accomplished much? How could he know?

As he walked, he saw odd markings in the wind-blown snow on the sidewalk, and thought at first they might be chickadee footprints. They followed no organized pattern, however—little gashes, smears and skidmarks in the drifting whiteness. In a few minutes, another gust would obliterate them.

Ahead, a leaf skittered past, leaving more evanescent marks in the snowy surface.

That's life exactly, Jim thought. Life and effort. Marks that vanish in a second. Blowing leaves, leaving nothing: *Nothing our restless, separated sleep: nothing is bitter and is very deep.* Thus, Derek Walcott.

"Hey," said a voice from the street.

Jim, absorbed, had failed to notice the police-car slow beside him. It had passed once a few minutes before, he remembered.

"Hi, officer," Jim said.

"You're out walking," the man said.

"Sure."

"You know you aren't supposed to," the policeman said. The man leaned toward the passenger door, the window of which he had lowered. He looked middle-aged, with the heavy features of a rich diet and a bristly face that hungered toward full beard and mustache. On another day he might have cast the cheeriest smile out the glistening-clean windows of the patrol car. He frowned today as if in imitation of that missing smile. "I could give you a ticket for that," said his wrong-side-of-bed face. "Less you have your prescription with you."

"Prescription? What are you talking about?"

"For walking. Don't act dumb."

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"Dumb? Prescription? For walking?" He wondered to himself, *Is* this Painesville? Home? Where someone harasses him for walking?

"Sure," the man said, his eyes widening. Redness mapped the whites as if they had seen a rough night. He leaned back toward his own side, opened his door, and rose to his feet. The effort seemed to take something out of him. His boots squeaked in the fresh snow. "Sure," he said again as he walked around the car. He leaned against it when he stopped. "And I suppose you're going to tell me you know nothing about it. I've been watching you. You've gone a couple blocks, and here you're still walking."

"Sure I'm still walking," Jim said, beginning to feel exasperated. "What else would I be doing?"

"Well, well, you don't catch the drift at all, do you, my man?" The policeman kicked a boot-toe that looked as new and polished as his expression looked overworked and tired. "You're breaking a law. That's what I'm talking about. Walking is a prescribed health activity, buddy. If you go unsupervised, without a prescription, and then you get yourself in trouble, who gets the rap? The city does. So you got to have that prescription. Did you know almost all auto damage involving auto-pedestrian accidents results from non-prescription walking?"

"Huh?" Jim said, disbelieving.

"I'm telling you for your own good," the man said, pulling a pad from his rear pocket. He uncapped a pen with his teeth, "I haven't given out one of these yet and I didn't intend to here, but you're acting so jack-stupid about this that it's what I'm going to do."

"You're giving me a—"

"Here."

"A *ticket?*"

"You just watch it now. Drive next time."

"You're crazy!"

"If you want to walk, then get yourself a scrip. And a better attitude, buddy."

"*Me* get an—"

He stopped himself, swallowing the words before they got out.

"So what do I do now? What if I get stopped again?"

"Then flash your ticket, man. They'll see you got the message," the policeman said, shrugging, smiling as if smiling came burdened with regulations and unhappiness. He slipped into his car. "Hang loose."

"Right," Jim said. He looked at the tag in his hand. *Eighty* dollars.

The official representative of Painesville had just met him, to welcome him home. Home, indeed.

The rep drove off, pursued by white ice-swirls in the road. Oddly it made him think of the *música del viento* that would swirl behind the procession of a saint carried to chapel. *Yo, Saints!* he wanted to cry out. *Where are you in this cold land?*

Jim turned at the next intersection, opting for the diner instead of the co-op. If he were to see Vicki again, he wanted to do so in a good mood. Any chances of that had slipped into that car and driven away.

Warm smells of simmering soup and cooking meat and potatoes

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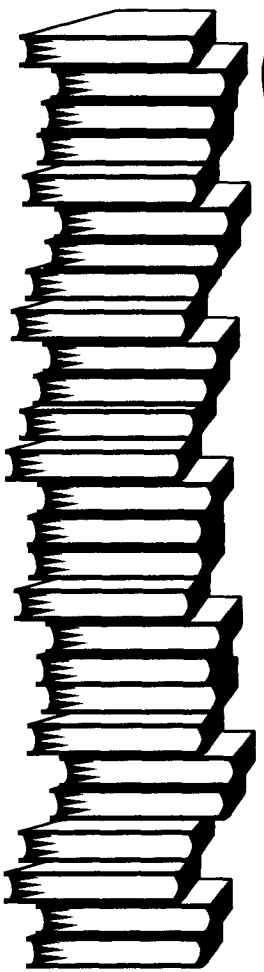

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greeted him at Millay's. His bad experience already beginning to fade in memory, he gratefully took a stool at the counter beside a man in a checked flannel shirt.

Millie noticed him, her fifty-something crowsfeet deepening in recognition.

"Jim, is it?" she said. "It's you, isn't it?"

"Sure is. Good to see you again, Millie."

"Long time no see, Jim. Long time. You went down a good ways away, didn't you?"

"Helped set up some farms, that's right. Way down in Central America."

"Well, welcome back. What can I bring you?"

"I think I might be getting a cold, coming back into this ice and snow. So I was thinking about some chicken soup."

A quiet fell over the diner for a second. Talk rose again immediately to wash over it.

Millie shook her head. "Sorry," she said, sounding genuine in her regret.

The man in the flannel nodded over at him. "You've been away for real, I guess. You know some idiot made health claims for chicken soup. Now you can't order the stuff, less you have the doctor say so."

"Huh?"

Millie shrugged. "My hands are tied," she said. "If you got a scrip, no problem."

"Scrip?"

"Prescription," the man said. "Frigging F.M.A. found out people were making health claims about chicken-bone soup—big surprise, right? I mean, your *grandma* probably fed you chicken soup when you got a cold, right? So what happens? The A.M.S. and the drug companies got their way with everything else that people make a health claim about. And chicken soup got sucked up into the damned regulations. Hell, it's just about getting hard to order a low-fat anything, even, let alone ordering it on whole-wheat. Or a damned bran muffin, for god's sake."

"Christ," Jim said. "You could say *water's* good for you, if you're dehydrated. They going to require a scrip for that?"

"Air, too," the man said, and shook his head with a resigned shrug of shoulders. "If you live in the big city and have ozone wreaking hell with your lungs, a bit of real air would be as good as medicine, wouldn't it? And by god they're *going* to require a scrip for pure air, I bet you."

"Can I get you something else instead, Jim?" Millie said.

Out the glass door he saw a familiar car pull up.

"Maybe later," he said, getting up. "I'll check back in a bit, OK, Millie? I'm just getting this feeling I better skedaddle."

"There's nothing wrong with *asking* for chicken soup, Jim," she said.

"Hope not." Jim grinned nervously as the policeman opened the glass door.

The red-eyed man nodded. "You got taste in eating establishments," he said.

"I used to," Jim said, slipping out into the cold again.

Even if his mood had hardly been

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improved, seeking Vicki sounded a lot more inviting than going back to the apartment and unpacking. Besides, he needed something against this cold. If chicken soup was out of the picture, then he needed something else. The year before, he had visited a local farm that raised coneflowers, *Echninacea angustifolia* and *E. purpurea.* Something along the lines of those Native American remedies might help, if he were to be denied the old European folk-remedy—not to mention the homey comfort—of chicken broth. Besides, finding Vicki would be akin to finding some community again.

Finding community. It struck him that he sought that, as much as anything, in his return.

He looked down the cold winter street at the closed houses with doors sealed, and windows doubled and tripled against the cold with weather-curtains pulled: the walls shut out cold and shut people in, stranding them on islands of individuality. Maybe they found community at Sunday events or weekend evening get-togethers with comfortable crowds of friends, or in pool halls or bars after work, or in bowling leagues or darts leagues. Or their only community might be found in front of the television. What had T.S. Eliot said? With TV, he said, millions of people could listen to the same joke at the same time, and still stay lonesome. Community indeed!

Not that things had worked much differently in C.A. For all the much-touted easy and relaxed pace of the tropics and near-tropics, families lived apart and developed circles of silence around them not so different from the silences surrounding these houses in the drifting snow. Women and children could occupy private spheres that might not open for hours; and men, if they were the ones leaving the house to earn a wage, would return home to enter that quietness, not to bring into it some part of the outside world. A society could be made of endless silences and private views, spaced contiguously without touching.

Jim had failed to do more than make good acquaintance among the men and women associated with the agricultural co-op project—failed, that is, until the first Fiesta. *That* hit like a wall of water. Instead of a flood that obliterated everything, however, the flood of the Fiesta shocked everything into life. People poured onto the streets, riotously discarding whatever silences had wrapped them twenty-four hours before, shedding whatever had clothed their noisy and exuberant insides. They exploded. Jim found himself exploding likewise alongside men, women and children on a suddenly electrical street, becoming instantaneously part of the community in a socially induced high that immaterially but still profoundly altered his place in the village for the remainder of his year. He found a place: a home. When the individual spheres of silence returned to the families, after the days of fiesta, none of it perturbed Jim: into his own small circle, within himself, he carried the community. He had failed to see where such circles of silence

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touched, before.

Here he knew no such event happened. Americans warmed towards a few Fiestas, called Holidays: but even as social energies burgeoned and threatened to burst outward at the onset of each one, everyone managed to hold it in, and to pull tightly into their individual households, and to make each a private event contained within four walls. Community, like so much else in America, had become privatized.

Turning onto Holdings Street, two blocks from the food co-op, Jim saw a figure moving in a distinctively furtive way, appearing like a gangling, dark stick from behind a snow-decked pine. The stick-man slipped across the street, where he held himself close against a building wall, scanning the view. He darted across again, to the farther corner.

Then his head clearly turned in Jim's direction.

He felt exposed and discovered. He pushed down the absurd thought: *What if he's undercover, trying to catch clandestine walkers?*

"Hey! Jim! Jim Malick!" said the stick-figure's full voice.

The man dropped all pretense of concealment, keeping about him only enough guard to glance against traffic to prevent being run down as he crossed the intersection again, running in a beeline until he stood in front of Jim.

"Paul!" said Jim, recognizing his friend.

"Hey, welcome back," the tall man said. "How was Belize? I got your cards, back there a few months. Sounded like you were having a fine time, though I don't know about that parrot meat you talked about."

Jim laughed.

"But I bet you missed this weather," Paul said.

"Maybe I did, Paul. Maybe I did."

Paul Ode, a Nigerian, possessed the kind of grin that split his broad face into unequal halves. His high cheeks, wide forehead, and lively eyes made up a face so prone to smiling that Jim could hardly remember any other expression on the man's face, although surely it had worn others—in fact Jim *must* have seen others, having sat through so many faculty meetings in his company. Paul Ode taught African and Asian literature and lived in a circle of silence that Jim had only partially penetrated, for all they had been committee buddies.

"I sure missed something else, too," Jim said. "Something sure changed while I was gone."

"I bet I know what you're talking about," Paul said. "I bet I do. The change. The big change."

"I just tried to get some chicken soup," Jim said, feeling the weirdness of what he was saying.

"And you couldn't." Paul nodded and then shook his head, his grin having become one of shared puzzlement at the enigma of life in the States. "Let me tell you, things have gotten strange."

"I guess so." Jim decided to leave unmentioned Paul's odd manner of walking only moments before. He fathomed its necessity, anyway: to avoid tickets. Paul had been an inveterate walker, too, eschewing wheels

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whenever possible.

"Just on my way to see Vicki," Jim said, "to find out what was going on."

"Ah." Paul's smile widened again while an eyebrow jutted high. "Then let's go this way."

"Co-op's moved?"

"No, but you'll see. Co-op's having troubles—"

"It was thriving, last I saw!"

"Yeah, Jim, but there was that big change. So now the co-op has troubles, because half what it was trying to do, the guvvy has spooned under, passing the scrip laws in that busy politicking way it has, trading this for other snafu stuff in the health-care wars."

"You lost me," Jim said. "Been speaking Spanish too long. What did you say?"

"The scrip laws. Anytime a health claim is made for a 'product,' then scrip's needed. The Food and Medicine Administration finally pushed it through, after getting up the steam through the eighties and chomping the bit for the last five, six years. Crazy, huh? And the American Medical Society went right along for the ride."

"Crazy isn't the word for it. I mean, chicken soup?" Jim looked uncertainly ahead of them. The town still felt strange to him. "So where're we going?"

Paul grinned. "Where we're going—think of it as guerrilla HQ."

"Whatever you say," Jim said. "What is it really?"

"A restaurant."

"Restaurant? A guerilla restaurant?"

"Right. Follow me."

With instructions so simply given, simple execution should have followed, Jim thought. Instead, he found himself picking up speed abruptly then hunching behind a juniper while Paul periscoped his head to scout the prospect. The tall man darted forward, losing footing a moment in the snow around the corner, and then taking a new position between a building and the wide trunk of a thickly knotted tree, an old maple that stood naked but dignified in the heavy weather. Snow fell again, lightly dusting the air.

Two stick figures, furtive but obvious against the white: they must look that way, he thought.

He wondered if the Spartans, with their rheumatism and their damp lowlands, would have taken it kindly if a false Asclepius had stood between them and the waterside willows from which they made their anti-rheumatic decoction. Asclepius, asking for payment for his scrip—insisting on granting *permission* for people to heal themselves? Hard to conceive! Would the Spartan soldiers have moved evasively to the river, as Paul Ode did through the streets of Painesville, or would they simply have taken out swords and hacked their way past the misguided healer?

And what would indigenous Americans have thought, had the tribal healer stood between the *Rhus radicans* and the *Impatiens capensis,* the poison ivy and its specific remedy, the touch-me-not? How could a *healer* stand *between* a problem and its cure?

For that matter, Jim thought, what

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would *he* have thought had someone insisted on his getting "scrip" after welts and discoloration had spread over both his arms? He would have suffered longer, then—much longer!

Instead, a true Asclepius had appeared, in the form of a small, pout-cheeked girl who looked disgusted at Jim's stupidity. She took him back to where he had brushed the poison-wood. There, in the same thicket as the *Metropium browneii,* grew *Bursura simaruba*—the funnily named Gumbo-Limbo, a tree whose inner-bark sap provided effective salve against poisonwood, much as touch-me-not did against poison-ivy.

How could he forget little Pia Calderón, frustrated at this tall Jaime "El Bobo" Malick who knew everything except what was useful?

"It grows here?" he said to Pia. "Why don't people grow some where it's handy?"

"Because it grows *here."* She said it as if saying that the *obvious* should be *obvious.*

"But wouldn't it be handier—"

"But the poisonwood's here," she said.

"Yes, but—"

"They *both* grow here," she said, giving her final word.

"Oh, together? They grow in the same place? Do they always?"

She shrugged and headed back down the path.

It made a crazy kind of sense in a way: plants humanly useful grew next to each other. He felt as though he had opened a page from the mechanist Deists with their vision of an interlocked humanity and Universe, or from that States philosopher of the strange, Poe, and his logical economy of nature. Some things argue for design in nature, whether or not design exists.

Rubbing in the Gumbo-Limbo salve, there along the path in the Belizean forest, the argument for design had felt forceful indeed.

Jim shivered behind Paul Ode, and followed him as he sprinted to a snow-covered park, ducking behind a high memorial bench of concrete inset with nobly postured Revolutionary War figures. Jim glanced at them and thought, *It's Boston Tea Party time, folks.*

"Come on," Paul said, motioning and then starting in a run across the park, his boots kicking up plumes of snow.

As they skirted a copse of pines, Jim's head brushed a low-hanging branch and received its benediction: a load of snow puffed out over his head, a few icy fingers reaching beneath his collar and making him shout in surprise. Paul shot him a curious glance, then powered ahead across the white expanse.

"It's *cold,"* Jim said.

"'S what winter's for," Paul shot back.

"Tell me about this big change you talk about, Paul," Jim called ahead. "How'd it happen?"

"Madness."

"Well, sure, it's madness."

"I mean literally, Jim," said Paul, slowing down. Snow puffed around his boots. "Madness in government. It happens every twenty or thirty years, seems like, when morality takes over

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from ethics, when words matter more than what's real, when politicians launch their egos on a thick cloud silver-lined with good intentions."

"Hell, I can see all that, Paul," Jim said. "But here—I mean, what's happened? I don't feel like it's my country."

Paul stopped, grinned, and nodded. "Exactly. We wanted it that way."

"We? Who the hell is 'we'?"

"Big Congress types and us little roustabout types. Look, Jim. The F.M.A. and the A.M.S. were pushing all through the decade to get a neck-lock on profits from medicine. *Any* kind of medicine."

"*The A.M.S.? But doctors aren't that* way—"

"I'm not saying anything about doctors. Doctors, individually—they're mostly a nice bunch. Hell, I got most of this info from Dr. Bagdasarian. You remember thin little Doc Bag, don't you? Sure you do. That big org that represents doctors, though—all through the eighties it was contributing lots of money to politicians who were pro-smoking and anti-gun control—more than it gave to ones who actually shared ethical concerns with the majority of A.M.S. members. The A.M.S. did it 'cause of economics. It's a money-driven org. Here at the end of the nineties it's the same thing. Economics. Money."

"OK. But you said not only them, but you, too. You said 'we.'"

Paul grinned. "That's right. When it looked like this legal hoohah was going to be pushed through by these loonies, some of us jumped on the bandwagon. We made sure that if they were going to regulate beta carotene and saw palmetto berries, they were sure as hell going to have to regulate chicken soup, too. We made sure if they were going to regulate peppermint tea, they had to regulate walking and any other kind of exercise, too. We wanted this, because—hey, duck down!"

Paul grabbed himself behind a snow-capped cedar, dragging Jim with him.

A moment later, a police-car cruised past without slowing.

"Close, huh?" said Jim.

Paul shrugged nonchalantly, peek*ing over the shrub before leaping to* his feet again. "Hey, come on! I see a crowd! Maybe it's happening!"

"Crowd? Happening?"

"At the restaurant! I think this is it, big-time!"

He went racing ahead through the snow.

"Hold on!" Jim cried, seeing where people milled before a store. Several police-cars had stopped with lights flashing. "What the hell you talking about? You *want* arrests?"

"Holy shit, yes—and look!"

"Vicki," Jim said, seeing but not believing his eyes. A crowd of people stood around a storefront that boldly advertised its illegal offerings: "Rose Hip, Peppermint, and Echinacea Tea: NO SCRIP NEEDED. Zinc-Propolis Lozenges: NO SCRIP NEEDED. Garlic Caps: NO SCRIP NEEDED. Wholefoods advice, free of charge: NO LEGAL LICENSE POSSESSED. Bran muffins: NO SCRIP NEEDED. Chicken

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Soup! *Chicken Soup!* CHICKEN SOUP! NO SCRIP NEEDED!!! HERE AT VICKI'S VICTUALS & TEAS! HOME OF ILLICIT-BECAUSE-HEALTHFUL BEVERAGES! EAT WELL BECAUSE IT'S GOOD FOR YOU!" They massed around the store carrying placards, some of them no more than sheets of paper: "I Write My Own Scrip," "Tea for Cups not Cops," and "Don't Give In To Uncivil Obedience!" Jim saw little Doc Bag carrying a sign bigger than he was: "Doctors AGAINST Govmntl STUPIDITY."

A pair of policemen led a proud-looking woman from the restaurant. She smiled grandly and serenely as if to be so led constituted a marvelous accomplishment. She wore her hair pulled back in a scarf, with a black wool coat falling nearly to her ankles. She moved like a queen, escorted toward one of the police cars. She smiled at the shouting crowd around her.

Her eyes widened when she glanced over.

"Jim!" she shouted with a smile as he ran near.

"Vicki! What the heck's going on?"

"Jim," she said again. "Hey, glad you made it in time for my arrest!"

"Your arrest? What's going on?"

She shrugged, still smiling. She looked at the policeman beside her, who nodded at her unspoken question. She stepped away from them, reached out to put one hand on each of his cheeks, and kissed him. "Welcome home," she said.

"Home? Home? This is home? You're getting arrested—"

"It's great, isn't it?"

She squeezed his cheeks and retreated into the waiting car, waving a hand at the cheering crowd.

"Jim," said Paul, "hey, this is great, isn't it? Wow—glad we could be here at the moment it all comes down!"

"But why?"

"Why? Because this is what we want. Listen. If the laws look like they're going to turn absurd, then you've got to make *sure* they're absurd—and then challenge them! When people see what's going on, they realize they've abandoned their government—and it spurs them to get involved again! It's just like you say—you don't feel like it's your country any more—so you fight to get it back! Now we just have to get ourselves a walking ticket. That would be icing on the cake."

"I thought we were trying to *avoid* getting one, just now."

"Hell, I was trying to look *suspicious,* Jim. Trying to *get* a ticket. We need one. We've got an arrest on serving chicken soup, and we've got an arrest on selling Echinacea tea. Now if we get a ticket on walking without scrip, then we're on our way to the High Court three-fold."

"Well, you know, I guess I already got—well—"

"What you say?"

"I guess I've got one already."

"A what? A ticket?"

"Sure."

"No!"

Jim held it out. He felt like he held not a ticket from a cop but an admission ticket to a weird and wild fair.

The crowd around them, momentarily silent at the revelation, erupted

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into a new cheer. Jim realized he stood at its center.

"You *want* this?" he said.

"Ha ha!" Paul danced around. "Our young professor!"

Jim suddenly thought of his chances at tenure. "But what if the dean hears—"

"I'm behind you. All the way."

Jim whirled. He hadn't noticed the man in the blue-grey, knee-length coat. Fat old grey-haired Dean Hegerman. Smiling approvingly.

As soon as he did he felt a blast of cold behind him, and the now-familiar feel of snow going down his neck.

"What the—"

He spun back, just in time to duck before getting a snowball in the face. From the reaction behind him, he judged Hegerman had received the missile. Jim grabbed snow and threw it at Paul. A dozen others plunged gloves into the white and cold, and turned the sidewalk into a blizzard of flying missiles. He caught a glimpse of Doc Bag lobbing a hefty one at a police car.

Somewhere inside him, some irritated part of him stopped itching. Jim thought of tiny Pia, of the poisonwood, and of healing, and shouted one in pure joy at the nonsense of the syllables: "Gumbo-Limbo!"

"What's that, some new dance?" said Paul just before getting a facefull. Dean Hegerman laughed.

Jim thought then of spheres of silence, dissolving beneath the hot Sun—

And dissolving now again, beneath the blinding flurry of still-falling winter white—

"Fiesta!" he yelled this time, feeling the inanity of the situation melting into something even stranger still but infinitely more comforting.

A jubilant enfilade of disrespectful missiles followed the departing police. One of the cars beeped a horn—then all did, as they disappeared. Vicki waved from a back window.

Community, he thought, laughing amidst the jubilation and the falling, falling snow. ■

We have a *sample* of *one* intelligent species to work with. From this sample of one we can deduce exactly *nothing* if we restrict ourselves to the use of statistics. We can compute all kinds of averages, height, lifespan . . . and the standard deviation?

Donald Kingsbury

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BIOLOG Jay Kay Klein

SF writers often start reading SF as teenagers, but Mark Rich was already notching up rejection slips by age 14. His first sale netted $2.30 for a poem in the *Denver Post*. Years passed before he made that much money again. After a music degree from Beloit College in Beloit, WI, he tried living off an assortment of artistic endeavors: piano player, rock band, and commercial art. Rich in name only, he felt a real kinship with the starving artists of ages past.

In the late 1980s, after some short stories appeared in various SF and literary small publications, Mark spent four years as manager of a floundering food co-op, joined an accoustic band, and developed an interest in prairie botany and prairie reconstruction. A collection of small-press short stories in 1991 won an award from the Council of Wisconsin Writers just in time to pay the rent.

Moving that year to Stevens Point, WI, he started writing full-time, plus working a few hours each week at a food co-op. A first sale to *Analog* for the May, 1993 issue came directly from a Stan Schmidt editorial. A second story for August, 1993 came from a desire to pay a debt to Isaac Asimov without engaging in an outright eulogy. Sales elsewhere followed, but appearing in *Analog* is a special treat, since Mark grew up adoring Freas and Schoenherr covers, and remembers early George R. R. Martin and Lloyd Biggle stories fondly.

Listing a writer's amazingly varied assortment of part-time rent-payers would defy space constraints, but Mark surely achieved note as instructor in invertebrate paleontology. Add a shotgun approach to fun-time interests and

(Biolog continued on page 108)

Photo by Martha Borchardt

Mark Rich

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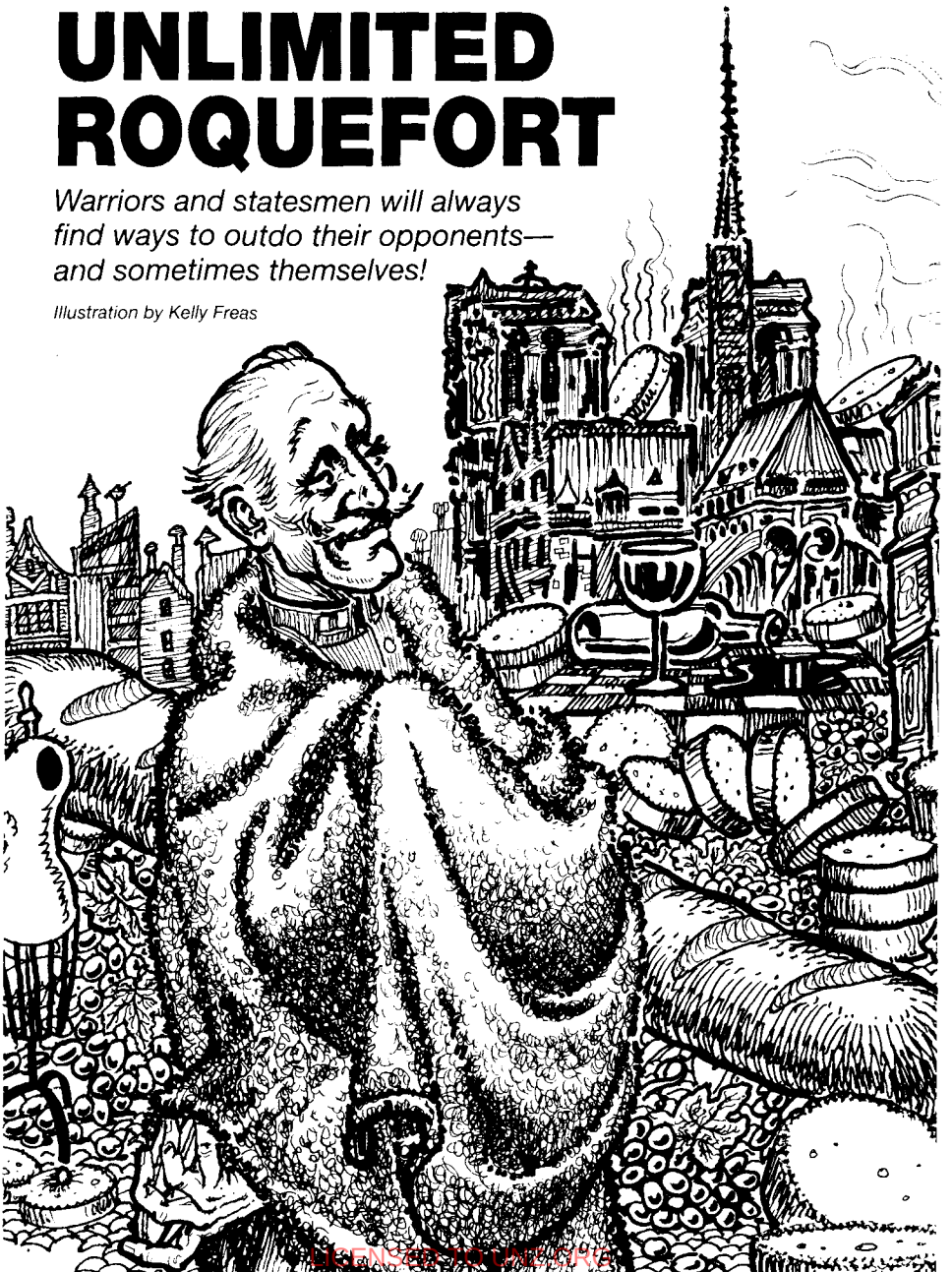
Hayford Peirce

UNLIMITED ROQUEFORT

Warriors and statesmen will always find ways to outdo their opponents—and sometimes themselves!

Illustration by Kelly Freas



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The room was somberly but richly furnished. The Permanent Secretary studied it with unabashed fascination. A Persian rug lay on the floor and a cheerful fire crackled in the hearth. Several thousand books lined one wall, while an up-to-date computer system occupied the opposite corner. The Permanent Secretary raised his glass of whiskey-soda and sketched a toast to the tall, gray-haired man who stood considering him.

"To being a free man, Colonel Christie."

"Twenty years to the day." The Colonel's voice was thick with emotion. He raised his own glass and drank deeply. "I thought I'd been left here to rot."

"No, no, my dear chap. That was never the intention. And it was as much for your own safety as for anything else."

Outside, the muted tones of Big Ben tolled mournfully through the late afternoon fog. "Safety? From angry mobs deprived of their cuppas? I suppose that's one way of looking at it." The Colonel gestured at his books and computer and uttered a weary sigh. "At least I had twenty years of uninterrupted calm to educate myself about all sorts of interesting things. Most, most interesting. Someday I'll have to tell you about them."

The Permanent Secretary nodded absently. "Yes, amazing what sort of information and courses one can get off the computer these days, isn't it? Oxford, Cambridge, even Harvard, I believe."

"But not the Sorbonne," said Colonel Christie with a hint of asperity to his clipped tones.

"No, not the Sorbonne," agreed the Permanent Secretary. "Things haven't changed *that* much." He set down his cut-crystal glass. "Well, my dear chap, shall we be on our way?"

"You have another tenant you're anxious to move in?"

"Into *here?* The Tower of London?" The Permanent Secretary raised an astonished eyebrow. "My dear chap, you've been the only guest the Tower has seen in the last forty years!"

"How on earth did you track me down *here?*" marvelled the other occupant of the pub's beer-ringed table.

"Amazing what information one can find on computers these days," murmured Colonel Christie.

"Particularly if one used to be head of Intelligence."

"Not head. Just . . . highly placed."

"Discreet to the very end," said Henry Hollilockes with unconcealed bitterness. "Even after what they did to you—and to me. And to *me,* Colonel Christie, to me! Working on *your* orders!" His mild brown eyes flashed with long-smoldering passions.

The Colonel nodded sympathetically. "I admit things didn't work out quite as one had anticipated. And that innocent bystanders inadvertently got hurt."

"Hurt, ha! How would *you* like to have spent twenty years of your life testing mayonnaise formulas for a chain of supermarkets out here in deepest Wales? *Me,* a biochemist with not one but *two* Chittering Prizes —and the offer of a professorship at Cambridge!" Small and round-shoul-

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dered, Henry Hollilockes gulped his beer and slammed the mug to the slimy table. He gestured at the mean surroundings of the squalid Welsh pub as if to encompass the last two decades of his life. "How do you like *this*, Colonel Christie?"

"Not too much, my dear fellow. And that, in fact, is precisely the reason I've gone to some considerable effort to track you down." The Colonel leaned closer, lowered his voice. "How would you like to help me take a measure of... shall we say, justly merited retribution upon those responsible for our sufferings of the last twenty years?"

"Retribution?" Henry Hollilockes blinked at the Colonel wonderingly.

"Yes. I've spent the better part of two decades educating myself about all sorts of things, some of them in your own field of expertise. I am now, I think I may honestly say, the functional equivalent of a Ph.D in microbiology, with a specialty in molds and fungi. Nothing to equal your own learning and experience, of course, but enough to give me the basis for a few most interesting ideas. Most interesting indeed, my dear Hollilockes." Colonel Christie's gray eyes suddenly glittered with an intensity that his acquaintances of an earlier life would have found both unfamiliar and deeply disturbing. "The most interesting of these ideas center upon a microorganism with which you yourself might be familiar from your dinner table—the *Penicillium roquefortii*."

"France," muttered Colonel Christie, turning a disdainful eye to the rocky wastelands that stretched away in every direction, "*La belle* bloody *France*!" Forty-five miles to the northwest of the Mediterranean city of Montpellier, here *la belle France* was distinctly unFrancelike, an unexpected vista of arid mountains and mesas that the Colonel thought could easily have been imported from the American Far West. A pitiless Sun burned down from a cloudless blue sky. Colonel Christie tugged uncomfortably at the neckline of his ancient tweed jacket and brushed an errant drop of sweat from his bony nose. "Damned Froggies, why can't they do things like everyone else?"

The Colonel had ample cause for discontent.

Two decades earlier, his Minister had indicated by a discreet series of hints and murmurs over afternoon tea that England's obstreperous Gallic neighbor was becoming entirely too big for its breeches and might usefully be taken down a peg or two.

Colonel Christie had attacked the project with his usual imagination and élan. What, he had asked himself, was the very soul of the French nation? Sex, food, rudeness?

The answer, of course, was wine.

Two months later a highly mutated variation of the fearsome phylloxera louse had been unleased upon France's vineyards, thereby destroying that country's single most important industry. The chaos in France had been immediate and absolute—and wholly predictable.

For a few short months Colonel Christie had basked in the glow of

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his Minister's approbation. Then the French had—as usual with them—fought back by totally unfair means.

Even now, twenty years later, the Colonel still shuddered at the monstrousness of the unexpected riposte. Using a mutated fungus of their own, the French intelligence service had overnight destroyed the world's tea supply. Bereft of its life-sustaining beverage, English society had been rent to its very core. Colonel Christie had been removed to his luxurious accommodations in the Tower—and a startlingly reinvigorated France had battled back to its former glory as the greatest power in the world.

No, reflected Colonel Christie, things didn't always work out as one planned them to. "But *this* one will," he muttered aloud, tugging again at his collar and taking a resolute step forward. The entrance to the rocky fortress of Mount Combalou lay just ahead, an enormous doorway through which the largest of lorries could pass with ease. Heart beating noticeably faster, the Englishman quickened his pace.

In the visitor's reception room the Colonel was given a thick woolen blanket by an amiable Frenchwoman with an impenetrable southern accent. He wrapped it around his shoulders and, with twelve other assorted tourists, began the descent into the four miles of caves and passageways in which the world's entire supply of Roquefort cheese was produced.

The air was cold and damp as it rose from the depths of the mountain's subterranean lake through hundreds of fissures and cracks, bearing with it the unique *Penicillium roquefortii* microorganisms responsible for creating the unmatched perfection of "the cheese of kings and the king of cheeses." Colonel Christie shivered as the group made its way slowly down through raw limestone walls and rocky grottos, deeper and deeper into the mountain. Eventually they came to an enormous cavern in which hundreds of thousands of plain white cheeses, produced by the farmers of the neighboring wastelands, had been brought to ripen. Stout oak planks stretched up to a ceiling a hundred feet above; here were cheeses in every stage of development, from the creamiest white to the most elaborately veined. Half a dozen silent workers appraised them with loving eyes, individually testing and turning them by hand.

Colonel Christie permitted himself a wintry smile. He had long since realized that he had been absolutely mistaken about that wine business. It was here, deep in the mountains of southern France, that he had found the very soul of this disagreeable nation; it was here that he would take his justly merited revenge.

The Colonel stepped forward as if to examine a particularly choice round of ripening Roquefort. As he did so, he activated the aerosol dispersal system so cunningly concealed within his trousers and walking boots. With an imperceptible hiss, millions of spores of the mutated *Penicillium roquefortii* created by Henry Hollilockes began to circulate in the

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air around him. A faint, abstracted smile on his lips, the Colonel moved slowly down the ranks of ripening cheeses, a tiny hissing noise accompanying him as he went.

"You do yourself well here," observed Henry Hollilockes with even more of his usual bitterness as his eyes ran over the high-ceilinged salon with its stunning view of Green Park.

Colonel Christie shrugged indifferently. "They never stopped paying my salary, you know. Compounded over twenty years, it came to a surprisingly tidy little sum."

"More than *I* ever made fabricating new and nastier mayonnaises."

"I dare say. But that isn't why I asked you to drop by. Come." The Colonel led Hollilockes to a gleaming kitchen lined with Italian tile and marble. He opened a restaurant-sized refrigerator. "Look." Hundreds of pieces of richly veined Roquefort filled the shelves. A loaf of bread and a scattering of fruits and vegetables occupied what little room was left. "I've been buying two or three pieces a day all over London for the last two months, ever since we calculated the first of the affected cheeses ought to be reaching the market."

"Yes," muttered the biochemist. "I still don't understand why we haven't heard anything yet. It ought—"

"Look. There and there and there."

Henry Hollilockes bent forward to scrutinize a head of lettuce. "Ahhh," he murmured with profound satisfaction, "so it's begun at last."

"You did design it so there'd be a delay, you know, to ensure they'd be distributed all over the world."

"Yes." A beatific smile suffused the biochemist's pinched features. "It's definitely on the lettuce."

"And on the orange."

"And on the grapes."

"And on the loaf of bread. Where, I wonder," mused Colonel Christie dreamily, "will it end?"

"Where will it *end?*" shouted the Prime Minister, his normally ruddy face now a dangerously mottled crimson.

Colonel Christie shrugged. "I see on the telly that it's already spread across all of southern France and is beginning to work its way north up through the Rhône and Garonne valleys. Anywhere, in fact, where there's something organic for it to grow on."

"You mean the whole damned country is about to turn into a piece of bloody Roquefort *cheese?*"

"Not cheese actually, just a countryside covered with a remarkably nasty blue and green slime."

"And it grows on *everything?*"

"Almost everything that's organic. Though not on human beings, or inside their lungs, for instance. That would have been a trifle near the knuckle to inflict even on Froggies." Colonel Christie smiled his wintry smile.

"Ah—so even Froggies are human beings: an interesting point of view." The Prime Minister took a deep breath, as if trying to keep his emotions under control. "But you do realize, my dear fellow, that this . . . this Roquefort *slime* of yours has also been found in *England!*"

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"Yes."

"And in the United States. And South Africa. And Singapore. And Australia. And . . . and *everywhere!*"

"Yes. Roquefort has a peculiarly worldwide audience, it appears." The Colonel pursed his lips austerely. "Never understood its appeal, myself. Always preferred a sound English cheddar."

"But that's just the *point*, you lunatic!" screamed the Prime Minister, unable to restrain himself any longer. "It's already growing on every cheese in England, even the cheddars! It is, not to put too fine a point upon it, growing on *everything!*"

"Yes," agreed Colonel Christie. "That was the intention."

"Your intention? To cover the entire world in green Roquefort mold?" The Prime Minister's eyes bulged.

"Only temporarily, Prime Minister." Colonel Christie cocked his head like an inquisitive bird. "You don't think I'd destroy the entire planet just to gain retribution for whatever paltry slights might have been paid me in the past?"

The Prime Minister sank bonelessly into the embrace of a deep leather chair. "I don't know," he murmured helplessly, "I simply don't know."

"Of course not, man," snapped the Colonel. "I'm not a monster, for heaven's sake. I simply want what is my due."

"And what is that?"

"A full pardon for any events that may have transpired twenty years ago, a baronetcy, and, of course, first and foremost, the restoration of our beloved England to her rightful place in the world. The restoration of British manhood to its finest flower, you might say."

"Of course, of course. What could be easier?" The Prime Minister shook his head in exasperation, certain now that he was harboring a madman. His finger moved toward the button that would summon his guards.

"Exactly. What *could* be easier? Nothing." Colonel Christie sighed. "Come, come, Prime Minister, I'm disappointed in you. Do you really think I'd come to waste your time unless I had a specific remedy?"

"A remedy?" The Prime Minister looked up, his mouth sagging. "You mean—"

"Certainly, Prime Minister. The mutated *Penicillium roquefortii* that is now running rampant around the world was only *half* our little bag of microbiological tricks. Already we see France reeling under the opprobrium of having released this genocidal mold upon the world. Soon it will be time for—"

"—The other half?" The Prime Minister allowed a desperate hope to take a tentative foothold.

"Exactly: the antidote. One that can easily be disseminated by aerial spraying. It takes effect almost immediately by breaking down the protein in the walls of the cells that constitute the mold. Within three days at the most, all that lovely green slime will dry up and wither away. And life will be back to normal."

"But—"

Colonel Christie raised a knobby finger and his voice hardened. "Life will be back to normal, I say, for those

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countries wise enough to have purchased the formulation for the antidote from the world's sole source."

"You mean—"

"Exactly: Her Majesty's government." Colonel Christie's eyes narrowed. "It will be interesting to see exactly what concessions you extract from Paris, Prime Minister, in return for preventing that miserable country across the Channel from turning into the world's largest piece of penicillin mold."

"The goal, I believe you said, was to strike a blow for British manhood?" The Permanent Secretary pursed his lips.

"Yes," agreed Colonel Christie. He swirled the remains of his sherry thoughtfully around the bottom of his glass.

"And to regain its rightful place in the world."

"Yes, that too," muttered the Prime Minister. "*I*, of course, did everything I could, went before the United Nations to offer the formula for the most modest royalties, even flew to Paris to negotiate under a flag of truce. Shocking behavior that, even for Froggies."

"Yes, an outright rejection. Said they'd found their own antidote."

"Muttered something about being the country of Pasteur and Curie, blast 'em." The Prime Minister scowled darkly at his empty glass, thrust it out to be refilled by Colonel Christie. "A cheeky lot, even when they're up to their necks in Roquefort."

"*Were* up to their necks, I'm afraid," said the Permanent Secretary. He sighed. "Their antidote worked even better than they said it would; it not only destroyed Colonel Christie's *surprise de Roquefort*, but, as a useful by-product of its withering away, it also seems to be regenerating the ozone depletion in the Earth's atmosphere."

"And now it's all been completely eradicated?" asked Colonel Christie. "Even here in the British Isles?"

"Oh, yes, everywhere. After cleaning up the rest of the world, the French were kind enough to send an entire flotilla of aeroplanes to every last cranny of this sceptered isle. They billed us, of course, in Swiss francs. But *Penicillium roquefortii christii* is now entirely a thing of the past, even here."

The Colonel sighed. "Ah, well, such are the vicissitudes of war."

"*Vicissitudes!*" The Prime Minister's scowl deepened. "That's all you have to say about it, man, about . . . about the greatest disaster in the history of England?"

Colonel Christie shrugged minutely. "Our antidote *did* work—at least when we tested it out." He shrugged again, sipped listlessly at his sherry. "Only, only—"

"Only it sterilized every male in the British Isles when we sprayed it on your say-so, you lunatic!" The Prime Minister's voice rose to a scream.

"Yes, that *was* unfortunate, I do admit. Something devilishly subtle about affecting the protein structure of developing spermatozoa, I believe. How was I or Hollilockes to possibly know?"

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"No child has been born in the British Isles in the past three and a half months," said the Permanent Secretary between gritted teeth, "except those conceived overseas. Already the nation's sperm banks have been completely depleted. France, I believe, has offered to send as much as we need from similar institutions of their own." He turned cold blue eyes to Colonel Christie. "And, I believe, I saw on this morning's telly six aeroplane loads of hearty young French volunteers—all of them male—arriving at Heathrow in order to help out with what one of them called *'la maladie anglaise'*." His stare intensified. "Do you realize, Colonel Christie, that singlehandedly you have wiped out the English race?"

"Ah, yes," murmured the Colonel, his gaze moving absently around the Tower room he shared with the Prime Minister. Finally it settled on the small teak dining table, "Ah, yes. A pity, that. Tell me, Secretary, do you think you could possibly ask the warder on your way out to send us up a nice piece of Stilton for dinner? Its veins are always so much bluer and tastier than a Roquefort's, don't you agree?" ■

EDITOR'S NOTE: You can read the prior history of this situation in the author's "Unlimited Warfare," in our November 1974 issue.

(Biolog continued from page 99)
you have someone who didn't fit into the usual educational straitjacket of becoming a narrow specialist. Reading and writing SF provides a framework into which he can fit his jigsaw-puzzle approach to making sense out of the Universe. SF suggests that rationality has a place in the world, and technology can make that a better world. SF is the interface of knowledge and society, with the individual sharing central place along with science.

Life is often so serious and tragic that one must laugh like Pagliacci to bear the serio-comic events Mark sees everywhere. Sometimes this breaks out in an irresistibly goofy streak such as Mark's naming of a pet tadpole "Shamu."

Analog remains the main home of SF that wrestles with the immediate problems facing us. Here, SF is a machine visualizing and creating the future. Mark writes with pencil, typewriter, and computer. The slowest method often produces the best prose and the fastest churns out the worst. A manual typewriter seems the best compromise, with a technology likely to usefully outlast any present-day computer, along with producing a gratifying clatter.

Stan Schmidt having appreciated Mark's typewriter pounding, there's a trumpet piece readying itself inside the author's head for an eventual very noisy, rocking dedication to the good doctor. ■

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THE ALTERNATE VIEW John G. Cramer

STRETCH MARKS OF THE UNIVERSE

This column is about the apparent quantization of cosmological red-shifts, the persistent astronomical observation that the red-shifts and velocities of distant galaxies are not randomly distributed but rather grouped in clumps of similar values. About eight years ago I had considered an AV column on this mysterious phenomenon, but after looking at the data then available I decided against it. As an experimental physicist I've seen too many "structures" in poor-statistics data that vanished as the statistics improved. Over the years, however, the red-shift data has improved to the point where the evidence that this is a real effect is now fairly convincing. So here it is, a persistent and puzzling astronomical observation that does not fit with our present understanding of the laws of physics and the Universe and that has no accepted explanation.

We live in an expanding Universe. Eon by eon, century by century, second by second as the Universe expands the fabric of space itself is stretching like the rubber of an inflating balloon. The galaxies that punctuate the vast open spaces of the Universe are growing farther apart as this expansion progresses. If two galaxies are separated by a distance of a billion light-years, their separation is growing by about .007 light-year every year. In other words, due to the expansion of space itself they are speeding away from each other at about 0.7% of the speed of light.

The remarkable expansion of the Universe was discovered in 1929 by CalTech astronomer Edwin Hubble, who showed that distant galaxies are systematically moving away from us and from each other. Hubble did this using the absorption lines of gaseous atoms as a star speedometer. As starlight emerges through the cool outer atmosphere of a star, the light at a few special frequencies is soaked up by certain atoms (hydrogen, helium, carbon) that have electron clouds tuned to absorb light at just these frequencies. If this starlight, arriving at an astronomer's telescope, is passed through a prism or diffraction grating

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to make a rainbowlike spectrum of colors, dark bands appear in the spectrum at those frequencies where atomic absorption has occurred. From careful laboratory measurements we know the frequency positions of atomic absorption lines to high precision, but 19th century astronomers discovered that in distant stars and galaxies these frequencies are shifted in frequency. The shift is usually towards the red end of the spectrum and is therefore called a "red shift." Astronomers assume that red shift is produced by the Doppler effect, which predicts a frequency reduction proportional to the velocity of a light source that is moving away from the observer.

Hubble was interested in systematic variations of the red-shift in stars. He selected populations of similar celestial objects, usually galaxies of a particular type, and examined the relation of the red-shifts of their absorption lines to their relative brightness (and therefore distance). What he found is now known as Hubble's Law: the red shift in the spectra of the objects grew as the objects became more distant. The farther away an object, the faster it is receding from us. This, Hubble concluded, is because the Universe itself is expanding.

Hubble's discovery led to a profound shift in our view of the cosmos. Before Hubble, the Universe had been viewed as an eternal object in some poorly-understood steady state, and the common assumption of cosmology was that the present era in which we are making observations is in no way special, that the Universe would look much the same at any point in time. Building on Hubble's work by extrapolating the expansion of the Universe back to its starting point, physicist George Gamow suggested the Big Bang model, which portrays the Universe as an evolving object with a pre-history that is very different from the present state. The discovery in 1965 of the cosmological microwave background radiation by Penzias and Wilson demonstrated the validity of Gamow's ideas and transformed the Big Bang model from a curious cosmological speculation to the standard model of cosmology.

Dr. William J. Tifft of the University of Arizona is one of many astronomers who have continued Hubble's work by performing increasingly precise red-shift measurements. Tifft's technique has been to focus attention on stars in the arms of many spiral galaxies and to measure the observed red shift of each. Since such galaxies should be randomly distributed in the Universe, one would expect the red shifts to also be random and to form a smooth distribution. Instead, in 1978 Tifft found that the red-shifts were grouped into clusters of similar values, and that the clusters were regularly spaced with a separation equivalent to velocity shifts of 72 kilometers per second. Such a "quantized" red-shift is completely unexpected and cannot be readily explained. Therefore, it is not surprising that Tifft's first reports of this phenomenon were met with great skepticism in the astrophysics community. Some skeptics noted that Tifft's quantiza-

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tion velocity is not much different from 60 kilometers per second, the semi-annual variation in the Earth's orbital velocity vector in its orbit around the Sun, and suggested that this velocity variation had produced the effect.

Tifft's results were so controversial that several groups of astronomers set out to prove that they were wrong by gathering data on red shifts more broadly and from a wider variety of galaxy types. To the surprise of the would-be disprovers, they found evidence for the same red-shift quantization that Tifft had reported. For example, a group of astronomers associated with the Royal Observatory at Edinburgh, Scotland, examined 89 spiral galaxies picked at random and found a periodic bunching of red shifts in their data that was similar to the 72 km/s intervals found by Tifft. The data they used came from many different observatories and many different telescopes, and it is therefore unlikely that some instrumental effects or systematic errors produce the observed red-shift quantization. The quantized red-shift phenomenon is not exclusively a property of the visible light spectrum of stars. Recent results from precision radio-telescope observations of spiral galaxies also appear to support Tifft's results. The quantized red-shift phenomenon won't go away. Astronomers are coming to accept it as a real phenomenon.

Are there theories that can explain the effect? Not really. Gravitational attraction is known to bunch galaxies into clusters of galaxies with similar red-shifts, but such bunches should be randomly distributed, not regularly spaced. Tifft's Arizona colleague W. John Cocke attempted to place the quantized red-shift effect in a theoretical ad hoc "quantum" framework by hypothesizing a "red shift" operator constructed to produce discrete recession velocities as eigenvalues of a wave equation. Cocke's approach, however, did not yield velocities spaced at even intervals. Instead, the *squares* of the velocities were equally spaced in the model. In later theoretical work, Nieto at Los Alamos devised a mathematical technique for producing evenly spaced velocities. However there is no physical justification for such a wave equation or red shift operator, nor is there any explanation of underlying mechanisms behind the suggested mathematics.

This is a science fiction magazine where a striking new physical phenomenon without an explanation should be welcome. The quantized red-shift effect should provide a fertile ground for physics and SF speculation. Are there gravitational standing waves supported by the "cavity resonator" of our closed Universe that are bunching distant galaxies into regularly spaced groups? Is space not as uniform and isotropic as we think? Perhaps as the Universe expands, the stretching of the fabric of space produces "stretch marks" where the weaker regions undergo rapid expansion while stronger regions do not.

Such speculations cannot be easily

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reconciled with the high degree of smoothness observed in the cosmological microwave background by the recent measurements of the COBE satellite. Perhaps, as Tifft and his colleagues have suggested, there are unknown large-scale quantum phenomena in the Universe for which we are only beginning to find evidence. At the beginning of the 20th century experimental physicists were probing the Universe at smaller and smaller distance scales, work that precipitated the discovery of quantum mechanics, the theory of the quantization of the very small. Now, as we near the beginning of the 21st century, astronomers and astrophysicists are hard at work probing the Universe at larger and larger distance scales. Will their observations precipitate a similar breakthrough discovery, the quantization of the very large? Watch this column for further developments. ■

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The man who fears suffering is already suffering from what he fears.

Michel de Montaigne

Security is mostly a superstition. It does not exist in nature . . . life is either a daring adventure or nothing.

Helen Keller

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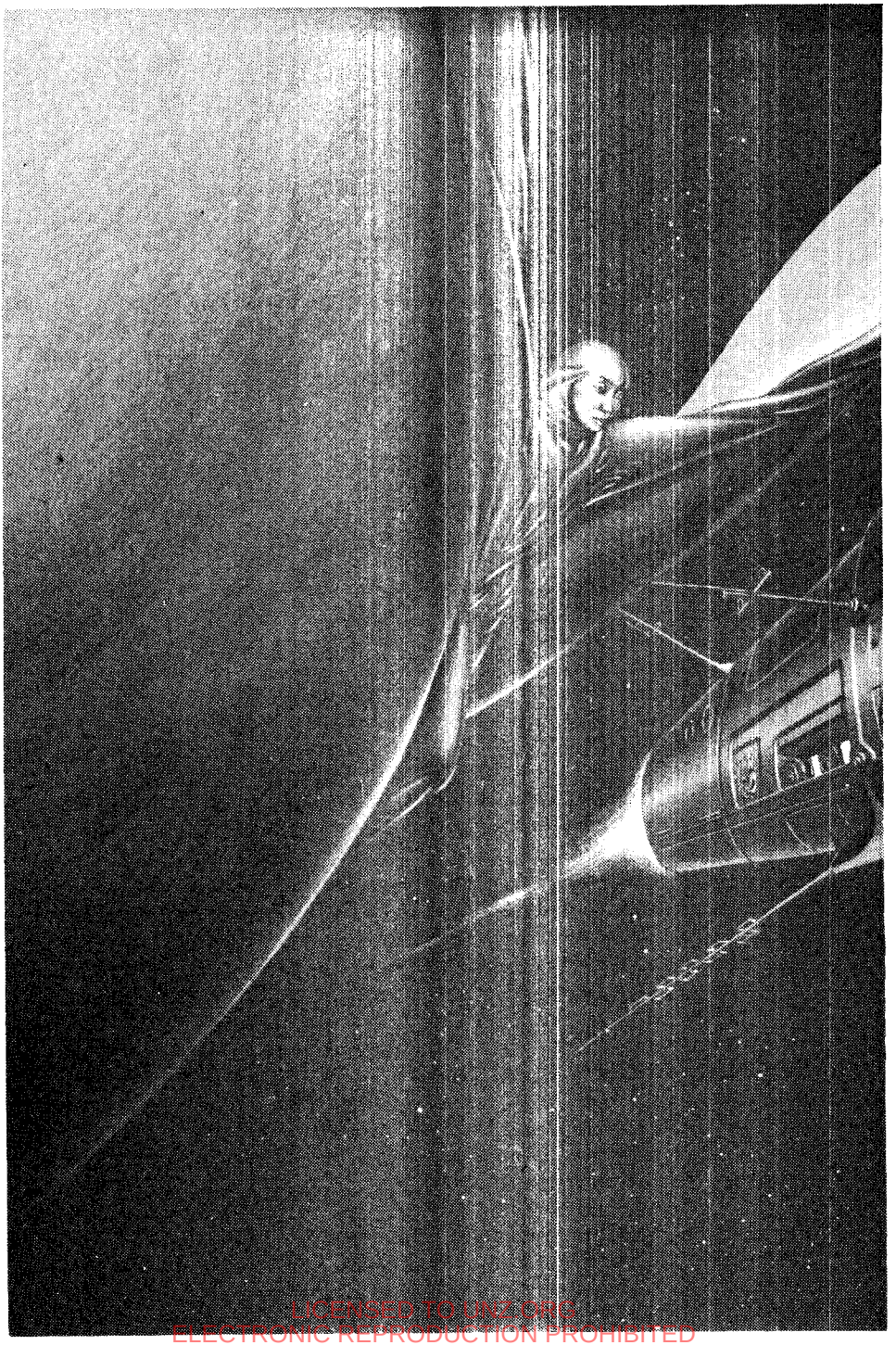

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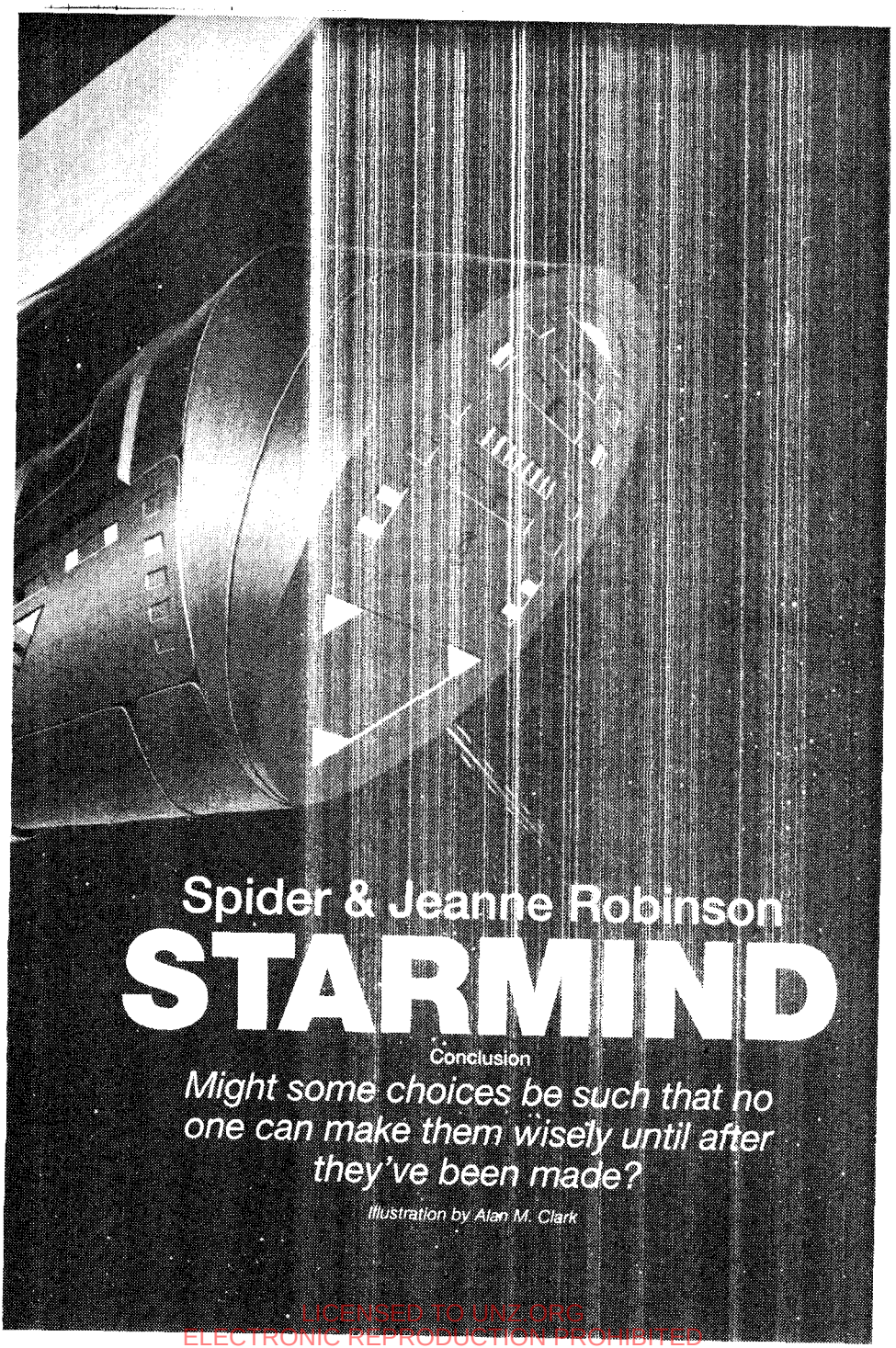

Spider & Jeanne Robinson

STARMIND

Conclusion

Might some choices be such that no one can make them wisely until after they've been made?

Illustration by Alan M. Clark

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WHAT HAS GONE BEFORE:

It has been sixty-three years since **Shara Drummond,** *the first zero-gravity dancer, danced her legendary Stardance for the Fireflies (the enigmatic aliens who originally seeded Terra with life: they returned to this Solar System in 2001, and left again shortly after). The telepathic groupmind Shara founded in space, THE STARMIND, has been growing ever since. It is composed of Stardancers—former humans, who have forever renounced the ability to live in a planetary gravity field, in exchange for telepathy and immortality. (Thanks to a Firefly-tailored substance called Symbiote, the complement of the human metabolism, Stardancers live naked in space, untroubled by hunger, thirst, cold, vacuum . . . or loneliness.) Their collective Starmind has been of great service to humanity, assisting in the safe development of vital new technologies—including nanotechnology—and in the cleansing of the human ecosphere. In return the Starmind asks only for trivial amounts of the trace elements Symbiote does not supply, and the right to exist. Naturally, humanity's original agreement to this bargain was grudging—but subsequent experience has confirmed that the Starmind has no need for anything that the human race considers an asset. Many humans appreciate Stardancer art and technology . . . but the overwhelming majority, of course, tend to ignore the Starmind's existence.*

As do **Rhea Paixao** *and her husband* **Rand Porter.** *Rhea is a successful writer, who has lived nearly all her life in her birthplace, Provincetown, Massachusetts. Indeed, Rand promised her, as a condition of courtship, that he would never ask her to move from her ancestral home. But now Rand, one of a handful of shapers (composers who also create their own holographic sets), has been offered an irresistible job as Resident Shaper and co-Artistic Director at the most fabulous hotel in space, the Shimizu. In order to work effectively with the Resident Choreographer and co-Director—his own half-brother,* **Jay Sasaki**—*Rand must* live *in the Shimizu.*

And any human who lives in free fall for an extended period will adapt—permanently. *Spacers (humans who live in space) are exiled from Earth as irrevocably as any Stardancer. . . .*

If Rand accepts the job of his dreams, he will become, for the first time, as famous as his wife. But if he does, Rhea must choose between her husband and her home . . . for herself, and for their eight-year-old daughter **Colly.**

The conflict being irresolvable, and the need for a decision being pressing, Rhea and Rand agree to stall. He will take the job for a trial period. Perhaps Rhea will learn to like life in space. Perhaps Rand will hate the job. At worst, the antinomy will be postponed.

This expedient creates a problem for Rand's half-brother. Even though Rand is *one of the four best Shapers alive, Jay used every drop of his own clout as Resident Choreographer to*

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get Rand the job. If his beloved kid brother doesn't stay, Jay will face the wrath of the Shimizu's manager, **Katherine Tokugawa,** *and his own job may be in jeopardy. But Jay would rather die than let Rand suspect his selection was even partly influenced by his big brother. Aside from Tokugawa, the only person in the Shimizu who knows the truth is Jay's best friend, a permanent hotel-guest named* **Eva Hoffman.**

Similarly, Jay is the only person in the Shimizu who knows that Eva is planning to end her life soon. At age 116, she is one of the oldest (and wealthiest) residents—and the only one who has ceased to cosmetically control her appearance. Jay is shocked to learn that she wishes to die, baffled by her reasons—something to do with the human race's refusal to either kill itself or straighten up—and terribly moved by the final favor she requests of him: that he dance for her, at her dying. He agrees to do so; and Eva agrees to postpone the event for a month while he choreographs her death-dance.

(Meanwhile, down on Terra, an unknown agency has begun working small, quirky, seemingly pointless miracles at apparently random locations. A chamberpot of urine turns to wine in Queensland, Australia, a dancer's broken ankle heals itself within seconds in Toronto; and so on. Most of these pass unnoticed by humanity at large, but soon there have been enough of them for the media to dimly sense that something odd is going on. . . .)

One month after Rand, Rhea and Colly arrive at the Shimizu, Eva meets privately with her old friend **Reb Hawkins-Roshi,** *a Soto Zen Buddhist abbot and retired Head Teacher of Top Step, the orbiting school in which humans learn to become Star-dancers. To the mingled relief and annoyance of Jay, a few hours' conversation with Reb accomplishes what Jay failed to do in a month of argument: Eva cancels her suicide.*

But death comes to the Shimizu just the same. A hotel guest named Wang Bin—a miner who had earlier drawn attention to himself in a tavern with drunken tales of a "white Star-dancer" he claimed to have seen out in the Asteroid Belt—manages to microwave his own brain with a home-made comm set while outdoors. And later that same day, a special Command Performance of some of Jay's and Rand's work for the five wealthiest living humans (present in the Shimizu for an economic summit) is disrupted by an assassination attempt which, though miraculously unsuccessful, leaves twelve dead—as well as the assassin himself, killed while trying to escape backstage by Jay, with assistance from Rand.

The hit-man's death leaves open the question of which of the five trillionaires was his intended victim, and which his employer. One of the five, **Chen Ling Ho** *(an old friend and sometime lover of Eva, and her escort to that evening's performance) is the grandson of Chen Ten Li, the twentieth-century statesman who was present at the birth of the Starmind. Ling Ho has spent his life making public reparation for the sins of his own late*

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father Chen Hsi Feng, an anti-Stardancer fanatic who launched a treacherous and doomed military assault on the Starmind in 2020, destroying a large quantity of Symbiote en route from Titan.

(Meanwhile, down on Terra, in the Kingdom of Lo, Nepal—which controlled all trade in the Himalayas until the 16th century, when the Kali Gandaki River changed its location and left the castle at Kechar Dzong literally high and dry—five centuries of patient prayer are finally and suddenly answered. The Kali Gandaki returns to Kechar Dzong, as abruptly as it left. . . .)

Attempted assassination proves almost a welcome distraction for Rhea. As the deadline approaches for her to give Rand a final decision on whether or not she can bear to live the rest of her life in space, she feels torn. Her husband has clearly never been happier, or done better work; she herself has gained enormous creative stimulation from space life, particularly from intimate "face-to-face" conversations with a Stardancer named **Buchi Tenmo.** *But lately Rhea is beginning to receive stimulation of a different sort from intimate association with Colly's guardian, the skeletally handsome young orientator* **Duncan Iowa.** *He is not only a spacer, but one of the rare space-born—as intrinsically interesting as his own obvious interest in Rhea is flattering. And Rand spends most of his waking hours in his studio, hiding perhaps from his own guilt at the impossible choice he has forced on his wife. Rhea finds herself seriously tempted to hide from that choice herself . . . in an affair.*

Even Colly, initially a zealous convert to space life, begins complaining that there are no children her own age in the Shimizu: who, she asks Rhea tearfully, will come to her ninth birthday party?

And underlying everything, Rhea is killingly homesick for Provincetown. Even the excellent holographic replica her shaper husband creates for her fails to satisfy: she cannot smell the rich aroma of sea or salt air.

A minor solar flare emergency strands Rhea, Rand, Duncan and Colly together in a tiny radiation-locker for eight hours. Between Rhea's growing temptation, Rand's growing suspicions, and Colly's dismay at being, for the first time ever, deprived of the Mad Hatter, her personal AI playmate, it is a stressful time for all. But paradoxically, the storm-shelter interlude seems to help reconcile Rhea to space life; she emerges showing every sign of a renewed commitment to her marriage. For the first time in months, Rand begins to hope. . . .

(Meanwhile, down on Terra, slums, shanty-towns and favelas around the globe are miraculously healing themselves overnight, hovels mutating of their own accord into modern, smart houses. . . .)

Then a major flare warning requires all passengers to seek shelter in the hotel's vast central swimming pool. When Rhea does not answer her phone, Rand races from his studio to save her . . . and finds her and Duncan, alone together, sweaty and blushing and hastily dressed. The Porter-

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Paixao marriage is over.

In a final irony, the flare warning turns out to have been a false alarm.

Jay feels mixed emotions. He is glad that Rand will be staying after all, that he'll get to keep both his favorite collaborator and his own job. But he is sad for Rand—and sad for Rhea—and heartbroken for little Colly.

Two days after Rhea and Colly return dirtside, Rand and Jay premiere their new collaboration, Kinergy. *It is an immense success. Even Chen Ling Ho, who has returned to the Shimizu to visit Eva, enjoys it—though his enjoyment is marred by imagery he finds uncomfortably reminiscent of Stardancers, whom (Ling confides to Eva) he secretly hates every bit as much as his famous renegade father did.*

(Meanwhile, down on Terra, economic upset looms as most nations record alarming unexpected increases in their National Surplus. Someone, it seems, is investing heavily—and anonymously—in funding art. Art of all kinds, worldwide. And claiming no deductions at all for the donations.)

Home in P-town again, Rhea finds to her dismay that she misses both Rand and space life. Yearning for them, she finds herself drawn into the informal and unorganized cult of Trancers, who gather spontaneously in public places to dance together: Trance-dance closely resembles free-fall dance in spirit and phrasing, and seems to induce a weightless state of mind. After a few weeks of dancing on the beach with Colly, she can feel her emotional wounds beginning to scab over.

Rand, missing her and Colly so fiercely he cannot work, visits Top Step for intensive EVA training. There he benefits from both prolonged meditation in space and Reb's compassionate counsel—and after a few weeks, when Top Step's famous maître-d' **Fat Humphrey** *decides to celebrate his centennial by retiring to the Shimizu, Rand decides to accompany Fat and Reb and their colleague* **Meiya** *on the trip: it is time he got back to work again.*

Upon arrival, he leaves the others in Fat's new suite and goes to fetch Jay to the party. But as they approach the door together, the Shimizu suddenly undergoes total—theoretically impossible—system failure. Lights go out, air stops flowing, AIs crash, pampered guests panic. . . .

Worse, the half-brothers find to their horror that Fat's door cannot be opened even manually. Somehow, the ultrasafe suite is in vacuum now. . . .

CHAPTER 21
High Earth Orbit
25 February 2065

Sulke Drager had always hated it when everybody talked at once. Thirty years as a member of a telepathic community had taught her a great deal about handling multiple inputs—more than any human being had ever known—but never before in history had so much of the Starmind all been sending at the same time. And underlying it all, pervading the whole Solar System like a taste of

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metal in the back of the mouth, was the wordless shriek from Saturn.

And naturally, the "voices" she most needed to "hear" were the weakest. They were also the closest, but distance means nothing to a telepath; signal strength and bandwidth were all that counted.

So she borrowed energy from every Stardancer in the heavens who was *not* shouting something, and used it to drive a message that had never before been sent across the matrix.

Shut the fuck up!

The System seemed to echo in the sudden relative quiet. Even the wordless wail from the Ring halved its "volume" and "pitch" and dropped back down into the region of speech. The words—*Save him Sulke!*—repeated endlessly, like a mantra.

And now Sulke could clearly hear the gentle voice she most needed to hear. *All right so far, cousins,* Reb said. *We are all unharmed so far, which means they intend to parley. Be calm.*

She knew his location precisely now. The vessel in which he was imprisoned was superbly stealthed—the combined power of the United Nations could not have found it—but she had detection gear no battle cruiser could match, if the target was another telepath. Reb had been one years before he'd met his first Stardancer; a natural adept. So were Fat Humphrey and Meiya.

So were four other humans currently in space, and fourteen on Terra. About average for humanity. All of them had been kidnapped too, at the same time as Reb, Fat and Meiya—every one was now a prisoner—but *this* vessel was Sulke's pidgin: the one she personally happened to be close enough to do something about. She instructed her subconscious to monitor the other ongoing rescue operations for data relevant to her own problem, and consciously ignored them.

She fed Reb's location to those who were good at orbital ballistics, grabbed the report that echoed back and swore. *You're going nowhere fast! Your trajectory is taking you up out of the ecliptic, and there's nothing there!*

He was still calm. *Naturally. We knew they must have a covert base in space; now they're leading us to it. We already know where the ones dirtside are being taken.*

Yeah, and we can't touch the place. What if where you're going is just as well defended?

Then we will have to be clever. And very lucky.

She went briefly into rapport with those who had had military training back in their human lives, and swore again. *We have Stardancers vectoring to intercept your projected path at multiple points . . . but there's no way to know where you're going until the bad guys decelerate. And if they maneuver in the meantime, we could lose you completely.*

They probably will. They're paranoid; they'll assume their stealthing may not be good enough, and try every trick there is.

I can match orbits with you right now, she said. *You're coming right at*

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me, near enough.

What about relative speeds?

She was already adjusting her lightsail, spinning out Symbiote like pizza dough. *You're a bat out of hell—but if I can grab hold, and it doesn't kill me. . . .*

She had an unusually powerful thruster on her belt she had never expected to use; she poked it carefully through the Symbiote membrane, borrowed a hundred brains to help her aim it, and fired it to exhaustion.

What can you accomplish? Meiya asked.

Tear off antennas, bugger up their communications, bang on the hull and distract them while you jump 'em. If I have to, I'll unscrew the fucking drive with my fingernails.

There was a hint of a chuckle in Reb's voice. *I love you too, Sulke. Wups! They're going to drug me, now. . . .*

Me too, Fat Humphrey said. *Watch your ass, Sulke.*

She could see them now, by eyeball, and they were indeed coming on fast. But she was confident; she had learned to board a moving freight when she was eight years old, leaving a place then called East Germany. *Yeah?* she sent back. *I'll give you a two-kilo gold asteroid if* you *can pull off that trick, pal.*

His answering giggle was the last thing she ever heard. She never saw the white-winged figure who came up behind her and put a laser bolt through her brain.

* * *

CHAPTER 22
Shimizu Hotel
25 February 2065

Jay remembered an old story from the dawn of spaceflight: a Skylab astronaut had awakened to a lighting failure, and had taken nearly twenty minutes to find the backup switch —in a sleeping compartment the size of a phone booth. Darkness and free fall were a disorienting combination.

He knew his way around Shimizu about as well as anyone alive—but in the eerie, feeble glow of emergency lighting, everything looked *different.* In places even the emergency lights had failed, and almost everywhere he and Rand encountered adherents of the ancient philosophy, "When in danger, when in doubt, run in circles, scream and shout." There was absolutely no doubt in Jay's mind that somewhere Evelyn Martin was hemorrhaging and tearing his hair out in clumps.

For the first time in his life, Jay did not give a damn about offending guests; he and Rand went through them like buckshot, leaving a trail of outrage and broken bones that was sure to give birth to expensive litigation.

The destination that would most efficiently allow them to find out what was going on, report what had happened, and do something effective about it, was Kate Tokugawa's office. There were other nerve centers, but that was the only one Jay was confident he could find in his sleep without AI assistance. It was startling to realize how much you depended on the damn things. *God help me if*

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I suddenly need a cube root or something, he thought wildly, bouncing a fat bald groundhog off a bulkhead.

Rand ducked expertly around the ricocheting guest and pulled up alongside him. "They couldn't have started losing pressure before the blackout, or we'd have heard alarms. To reach zero by the time we tried that latch, they must have blown out *fast.*"

"The whole window must have gone," Jay said.

"Is that possible?"

"No. Not without help."

"So they're dead?" He clothes-lined an employee who was, quite properly, trying to prevent them from speeding recklessly through a developing riot—and, since it was the quickest way to explain, regretfully sucker-punched the woman as he went by.

"Probably. But maybe not."

"How do you figure?"

"I ask myself, what could take out a whole window? I come up with a ship designed for the purpose. I think they've been snatched. I think when they jaunted into that room, the window was already gone: *they saw a holo of one.* And at some point they all got sleepy."

"And somebody came through the holo and towed them away... wouldn't somebody *notice* a fucking barnacle attached to Shimizu?"

"Remora," Jay corrected. "It moves. Not if it was stealthed well enough. Fat's room is all the way around from the docks. And by now it's gone—and the sphere of space within which it could possibly lie is expanding every second. You can spot even the best-stealthed ship by eyeball, by occultation of background stars—but you have to know just where to look."

"Maybe we should quit dawdling, then." They were into the final corridor now, a straight run of perhaps two thousand meters; perhaps a dozen flailing figures cluttering the way between them and the door to Management country. Rand lifted his head, bellowed "FORE!" at the top of his lungs, tucked his chin and triggered all his thrusters at max.

Jay did likewise. Miraculously, everyone managed to scatter out of their way. Halfway to the door, they shut down, flipped over, and began to decelerate—and discovered that they had both burned themselves dry. They impacted with bone-jarring crashes, desperately grabbed handholds, and nearly had their arms pulled out of their sockets by the rebound. Jay's first thought was for Rand, but his brother threw him a shaky grin and a circled thumb and forefinger.

Jay found the manual doorlatch and released it. He was greatly relieved when this one worked; he had not been sure he would find pressure in Management—and had had no idea what to do if he didn't. They scrambled in together, then resealed the door to keep out guests who wanted a refund. There was nobody at the front desk, nor in the outer offices beyond it. "Where the hell *is* everybody?" Rand snarled.

"I don't know," Jay snapped, even more nervous than his brother. This

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was wrong, wrong— "Wait a minute." He doubled back, went to the front desk. "I filled in for a guy once or twice," he said as he got there, and began tapping code on a drawer under the counter. "Let's see if they still . . . ah!" He got the drawer open—and took from it a totally illegal police-issue GE hand-laser. "Sometimes security doesn't show up fast enough when you call them," he said, checking the charge and clicking off the safety. *"Now* let's go see what's in back."

"I'll go first and draw fire," Rand said. He and Jay exchanged a glance. It became a grin. "The Hardy Boys in High Orbit," Rand said.

"And in a big-ass hurry."

They worked their way back through the outer offices to Kate's door cautiously but quickly, Rand preceding his brother through every doorway. Finally they floated outside her office.

"No point in listening at a soundproof door," Jay said.

"No point in knocking, either," Rand agreed, and opened the manual release compartment. "I'll go first, again."

"No need. I'll *know* where the target is, if there is one."

"OK. If there's trouble in there, you go right and I'll go left."

"Which way is that?" They happened to be upside down with respect to each other.

"You go away from me and I'll go away from you." Rand unlatched the door. It let go with a pop, and opened a few centimeters. He gripped the release latch to brace himself, and slid the door the rest of the way open. He and Jay entered together, and stopped.

And then both began to laugh.

They knew it was inappropriate; that only made it worse. Facing them was one of the most ridiculous sights they had ever seen: Evelyn Martin, holding a gun.

Laughing, Jay tried to move away from Rand as agreed—and remembered that his thrusters were dry. He still was not worried; he and his brother could outjaunt a spastic like Martin with muscles alone.

Then he saw Katherine Tokugawa well to his left, also armed. His laughter died away. They were outgunned. He shook Rand's shoulder and pointed her out. After a microsecond's thought, his own gun steadied on Martin. If he were going to be killed by one of these two, he preferred Kate. More dignity.

"Drop it," Martin yapped.

Jay thought hard for a whole second, then opened his fingers. The gun, of course, stayed where it was.

"Lose it," Martin corrected, expressing his exasperation by putting a bolt into the wall beside the doorway. The smell of burning bulkhead plastic filled the room faster than the air-conditioning could suck it away. Jay gave his own gun a finger-snap, like a child shooting marbles; it drifted away toward Martin. Ignoring the man, he turned and addressed Kate.

"I should have figured you'd have to be in on this," he said. "But I'm damned if I can see how you expect to come out of it with your job."

"Oh, I'll probably lose that eventu-

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ally," she agreed. "But by then I'll have a better job."

"A better job than *this?*"

"Much better. I'll be running something a little more prestigious than a hotel."

"What's that?"

"High Orbit," Martin said, and snickered.

"Shut up, Ev," Tokugawa snapped.

He stared. "What the *hell* are you talking about? Nobody runs High Orbit."

"No," Martin said. "The UN wouldn't let them. But the UN isn't going to be around much longer." He giggled nervously.

"Shut *up,* Ev," Tokugawa barked. "*You can tell them things like that* after they're dead. Not before."

Jay tried to restart his laughter; it didn't catch. "You seriously think you can take on the UN—and the Starmind—and win?"

Kate couldn't resist answering. "Not me," she said. "But I know people who can. I've been working for them all my life."

"You artists are always yapping about your 'vision,' " Martin said, and brandished his gun. "Ha! You assholes don't know what vision is! We're gonna reshape the future."

Jay felt the Universe shifting in his head, crushing his brains beneath it. Surely this was lunacy. Even the UN itself could not have defeated the Starmind. He could conceive of nothing human that could.

"Come in, gentlemen," Tokugawa said then. Jay glanced over his shoulder, and saw two security men enter with guns drawn. Each, he noticed, wore an unfamiliar earplug and an unobtrusive throat-mike. Communications gear that did not use the house system. Turning back, he saw that Tokugawa and Martin both had them.

"So," he said to Kate, "you already know more about what happened in Fat Humphrey's room than we do."

She nodded. "Oh, yes. Much more."

"Of course. You assigned Fat his room. So this is where you gloat, and tell us what's going on, so we can be awed by your cleverness?"

"No," she said. "This is where you get taken away and killed. Goodbye, Sasaki." She sketched a *gassho* bow. "It has always been a pain in the ass to *work with you. Martin, you go along* with them—make sure it looks pretty; that's your line of work."

Jay opened his mouth to say something, but never got a chance to learn what it was going to be. Something touched the back of his neck, and he slept.

It was a very troubled sleep, full of unpredictable accelerations that triggered horror-dreams of falling from his terrestrial past, and unfamiliar voices shouting incomprehensible things in the near and far distance, and the nagging certainty that something he couldn't quite recall was terribly terribly wrong.

You were *meant* to come out of the drug confused. But his surroundings when he finally did certainly enhanced the effect.

He was in a corridor. Not a public one, a . . . the term took awhile to surface. A service tunnel, that was it. The

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lighting was even lousier here. Things were floating in his vicinity—important ones, he sensed. First he counted them: four. Then he classified them: human beings. Next he laboriously identified them. Evelyn Martin. His third-grade gym teacher—no, that was . . . was . . . right, one of the security guards who was going to kill him. Sure, there was the other one. And the extra one . . . hell, know him anywhere: that's my bro. Like a brother to me.

So now he had them broken down into two groups. Friends: one. Foes: three. That didn't seem like a favorable ratio. On the other hand, one of the guards seemed to be lacking a face; that evened things up a little. And Ev Martin's head hung at a funny angle. . . .

A few more foggy seconds of contemplation and he had a second breakdown he liked much better. Rand was breathing; the rest were not.

The example inspired him; he breathed deeply, stoked his brain with oxygen and felt the cobwebs begin to melt away. *This is great,* he told himself. *How did I do this?*

As Rand began to show signs of recovering consciousness too, a hatch opened nearby and Duncan Iowa appeared. "Good," he said. "You're awake. I ditched their comm gear on the assumption it's trackable, but we ought to move anyway. No telling which systems they have up and running." He moved to Rand, started to slap him awake—then thought better of it, and instead spun him, to centrifuge blood into his head. "Take this and keep lookout," he added.

Jay got his hands up in time to catch a laser considerably more powerful than the police-issue job he'd liberated from the front desk. He blinked at it for a moment—then snapped out of it. He checked charge and safety, assessed the tactical situation, and assigned himself a guard post. "You're something else, kid," he said wonderingly. Duncan ignored him, busy with Rand.

Rand spent less time in stupor than Jay had. Groundhogs and new spacers usually shook off drug effects faster; their blood pressure was higher. He looked around at the drifting bodies, shook his head like a horse shooing flies, glanced at Jay and turned back to Duncan.

"I punched you in the mouth," he said wonderingly. "And you let me live."

"I had it coming," Duncan said tightly. "Look, we've got to move. I don't need to know who we're running from or why just now, but if you know anything that would suggest where to, I'd love to hear it."

"Shit," Jay said. "I wish I knew more about riot-control procedures."

"What do you need?" Duncan asked.

"For a start, a large tank of sleepy gas with a hose on it."

"Come on," Duncan said, jaunting away. "I'm an Orientator—I know this dump better than Kate Tokugawa."

I hope you're right, Jay thought. Rand jaunted after Duncan, and Jay took up the rear, gun at the ready.

* * *

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In the discreetly unmarked riot-control compartment Duncan led them to, they found the tank Jay wanted, fresh thrusters, and a sonic rifle for Rand. While they swapped the new thrusters for their exhausted ones, they also exchanged information.

"I was heading for Deluxe country, I knew the panic would be worst there, and I took service corridors to make better time. Then I saw Martin and those two goons go by at an intersection ahead of me, guns out, towing you two. They didn't see me in the shitty light."

"What made you decide to butt in?" Rand asked. "And how did you *know which side you were on?*"

Duncan didn't duck the question. "I'm in love with your wife, and she's in love with you. I didn't want her hurt."

Rand didn't duck the answer. "I understand. How did you ever manage to take all three of them?"

Duncan shrugged. "All three were Earthborn. Taking Martin's gun wasn't a major challenge. Actually the other two didn't do too badly; I was trying to keep one of them alive to question, but they hurried me. So tell me: who are the bad guys and what do we do about them?"

"Anybody could be a bad guy," Jay said. "But the one we know about is Kate Tokugawa herself." Duncan's eyebrows rose, but he made no comment. "And what we're going to do is take her alive for questioning. But I almost hope she hurries us. She's behind the system crash—she's using it to cover a kidnapping."

Duncan's eyes widened, then shut tight. "Jesus."

"You think they're alive, then?" Rand said.

"Have to be. There are much easier ways to kill somebody."

"Easier ways to kidnap people too. They could have snatched us off the shuttle without all this hooraw."

"The Space Command keeps a careful eye on moving objects in High Orbit," Jay said, "but they hardly ever look at the Shimizu. Doing it here cost the bastards, but it probably bought them enough lead to get away clean."

"Who got kidnapped?" Duncan asked.

"*Fat Humphrey Pappadopoulos*, Reb Hawkins, Meiya, and Eva Hoffman. Possibly others, but I'm sure of those. They snatched them right out of a suite; right out the goddamn window and into a stealthed ship, long gone by now. I don't know what the fuck is going on, but it has something to do with a coup against the UN."

"Jesus Christ!" Duncan said. "An honest-to-God old-time coup d'état?"

"I think *coup du monde* is more like it, from the way Ev was talking. I don't care what historians call it, as long as they put 'failed' in front of it. So we need Kate—alive, and with her vocal cords intact; everything else is optional. She's in her office . . . and I think I know how to get her out, if we can get there alive. But that might be a problem. I'm sure she has a private surveillance-and-defense system. She let us approach the last time because Martin didn't want to have to explain embarrassing laser burns on

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our corpses to the cronkites—but if she sees us coming again, I don't think she'll hesitate."

"So what's the plan?" Rand asked.

Jay sighed. "I was hoping one of you would come up with something. I don't know how you storm a castle with a slingshot when they know you're coming."

"I do," Duncan said. "You use the servant's entrance."

Twenty minutes later, they peered out through the grille of an air-circulation tunnel ten meters from Tokugawa's office door. They were all wearing stock p-suits scavenged from the riot-control locker, but maintaining radio silence. Jay unsealed his hood and sniffed the air; when he didn't pass out, the others did the same.

"I think we're inside her perimeter," Duncan said. "I don't see anything in that hallway that looks like the business end of a laser."

Jay wedged past him and looked. Bare walls. He clutched the tank of sleepy-gas to his chest. "So one of us tries it and the other two avenge him if necessary."

"Let's not rush into this," Rand said.

Jay laughed mirthlessly. "Feel a little stuffy in here, bro?"

"Now that you mention it, I'm sweating like—oh!"

"When a groundhog starts to sweat, he smiles and reaches for a cold beer. When a spacer starts to sweat, he reaches for his p-suit." The hotel's backup system had power for air circulation and limited lighting—but none for cooling. Shimizu was a shiny ball of metal in the sunshine, full of heat-producing people, and contrary to groundhog belief space is not cold at all. "Folks are going to start dying if the system doesn't come back up in the next hour or two: we're running out of time."

"How do you plan to get her to open the door for your gas?" Duncan asked.

Jay grinned wickedly. "I don't need to. Ev Martin drilled a neat little hose-size hole for me about a meter Earthward of the door." He started to push the grille free, but Rand stopped him.

"Let me," he said.

"I claim privilege," Jay protested. "I've known Eva and Reb a lot longer than you."

"My point exactly. You said before you almost hoped she'd hurry you. I don't. I have less need to find an excuse to kill her."

"That could get *you* killed."

Rand grinned. "Well, bro, just now the world doesn't need a first-class shaper as badly as it needs her."

"I'm faster than both of you put together," Duncan said.

Rand turned to him. "Yeah. But that's a massy tank: you haven't got the muscles to hump it. Some things, Earthborns are better at. Besides, it's my turn to do something heroic. OK?"

After a moment, Duncan nodded. "Good luck."

"Thanks."

After all that melodrama, the capture itself was ludicrously easy. Everything went like a good opening night, just enough adrenaline to keep

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you in top form and no surprise you couldn't cope with. There were hidden gas-jets in the hallway—but p-suits made them irrelevant. The laser-hole by Tokugawa's door was the perfect gauge for Rand's hose. She had a p-suit stashed in her office and managed to reach it—but passed out before she got its hood over her head. Once they had access to her terminal, Jay and Duncan between them were able to coax the system back up and on-line in a matter of minutes. As the main lights came on, they could almost feel the cheer reverberating around Shimizu. Then, ignoring the hundreds of incoming calls, they put in an SOS to the Space Command, and soon found themselves talking to an Admiral Cox, an old warhorse who was most interested in—and totally unfazed by—an attempted overthrow of the planetary government. With a minimum of words, he extracted from them every scrap of useful information they could give him, then put them on hold.

Despite a mild sense of anticlimax, Jay felt himself grinning. "We did it, guys," he said.

"Hell of a note," Rand said. "I started the day a respectable artist—and now I'm running a goddamn hotel."

Jay giggled. "You may be going out there just a star, kid... but you're coming back a waitress."

"You know," Duncan said. "I always *thought* I could run this dump better than that asshole." He gestured at the sleeping Tokugawa, and all three of them broke up. She did look silly. In the absence of gravity, simply binding a person's wrists and ankles does not immobilize her effectively enough; instead you tape each wrist to its related bicep, each ankle to its thigh, then tape elbows and knees together. The result looked remarkably like a Buddhist in the midst of prostrating herself.

But their laughter chopped off short when they noticed that she was no longer breathing.

"...And about half an hour later, Commander Panter showed up with six Marines in full armor—and here we are," Jay finished. He glanced at his watchfinger. "I'd say she died about two hours ago. That's everything we know, Admiral."

He and Rand and Duncan were in a place any small boy would have killed to visit: the command center of the Citadel, the UN Space Command's principal fortress in space. It looked just like it did in the movies. The only person with them now was Admiral Cox himself, a grizzled old centenarian with a startlingly warm smile —but Jay knew perfectly well that every word he'd just said had been heard by literally hundreds of people on and off Earth. It was beginning to make him distinctly uneasy, too. Cox was treating them as vip guests —but Jay was beginning to suspect how long it might be before he slept in his own bed again.

Cox sucked coffee from a battered military-issue bulb, and nodded sadly. "Post mortem shows a fatal allergy to sedation, iatrogenic, of course. Her superiors didn't even give her an option. They wanted her interrogation-

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proof. Interesting people."

"I'm sorry, Admiral. We should have thought—should have given her antidote right away—"

Cox shook his head emphatically. "There was no other way to take her; you'd have thrown your lives away trying. And it was too late for antidote the moment she lost consciousness. More coffee, gentlemen?"

Jay had been too busy talking to consciously taste his; he queried his tongue and learned that the brew had come from the Atherton tablelands of Queensland. "Yes, please, Admiral." The others accepted as well, and a servobot much uglier and clumsier than anything in the Shimizu brought them fresh bulbs.

There was a short silence while they all drank. Rand broke it. "We screwed up," he said hollowly—and Jay felt himself nodding in agreement.

"On the contrary!" Cox said. "You walked among the lions today, son, and all your blood is still on the right side of your skin. Are you sure none of you has had military training?" All three shook their heads. "If you were my plebes, I'd be sewing stripes on all three of you right now."

"But we don't know *shit,*" Rand insisted.

"We know a lot more than we would if you three had gotten yourself dead trying to take her cowboy style! I'd be sitting here right now, listening to Kate Tokugawa tell me the emergency was over and thanks, but they didn't need any assistance. Who knows how long it would have taken for someone at Top Step to try and call Humphrey, and get a no-such-guest-in-house? Now we've got everything you learned, *days* before they thought we would—and five low-level thugs we were able to take alive, we can sweat them—"

"—And it all adds up to doodah," Jay said. "If the Security goons know anything useful, they'll be allergic to interrogation. And what we know just doesn't make any goddam *sense.*"

"Not by itself, no. But it may tie in with other things. Tell me, would you gentlemen consent to hypnointerrogation? You may know things you don't know you know."

"On one condition," Rand said.

"State it."

"Admiral, this is high-level stuff. I'm a civilian. I want your personal word that when you put this all together, you'll share it with me. I'll take any kind of secrecy oath you want—trigger me up like a courier if you want, so I *can't* talk—but I have to know. Not what the cronkites get told, but the truth."

"The same goes for me," Jay said.

"Me too, Admiral," Duncan said.

Cox did not answer right away, and they did not hurry him. He met each pair of eyes in turn. Finally he said, "I agree to that, whether you consent to hypno or not. You've earned it. For a start, I will tell you that yours wasn't the only kidnapping. Data are still coming in but there have been at least two others in space, and more than a dozen dirtside—beautifully coordinated, assorted methods but 100 percent success rate. I am not aware of any other military engagement in modern history accomplished with such elegance and efficiency. Billions

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were spent. Well spent."

"What kind of people were taken?" Jay asked.

"Saints."

"What?"

"Holy men and women. Spiritually enlightened people. Like Reb and Meiya—and Fat Humphrey too, in his way. Several different faiths, and two whose religion has no brand name at all, but they're all what Reb would call *bodhisattvas.* Mother Teresas, if you're old enough to get the reference. You know: saints."

"You mean like the Pope?" Duncan asked.

"I didn't say religious leaders. I said spiritually enlightened people. One of them seems to be an Aboriginal witch woman. Another is a Pakistani musician who only plays hospitals."

"Of course," Rand said, slapping his forehead. "What's wrong with me? You want to overthrow the UN, naturally you kidnap saints, musicians and fat maître-d's."

"It just keeps getting worse," Duncan said. "More than a dozen perfect military operations, carried out by wealthy morons."

"Admiral, is there anything the captives have in common *besides* . . . well, besides holiness?" Jay asked.

Cox lifted one bald eyebrow respectfully. "You do keep surprising me, Sasaki-*sama.* One and only one overt connection between them. They are all known to be on especially intimate terms with the Starmind."

Rand's eyes showed a gleam of excitement. "Some sort of hostage deal—" he began.

"I've asked the Starmind for their evaluation of the known data," Cox said. "It can take a week to get an answer from them on a simple question, sometimes, but they've promised me at least a preliminary answer by 1200 Greenwich, about . . . " He winked briefly; his watch was inside his eyelid, " . . . twelve hours from now. You'll have slept off the hypno by then. Meet me here at noon and you'll hear anything I do."

As far as Jay was concerned, he woke up with a click, totally refreshed and restored and in a comfortable bunk, one second later. He never managed to remember anything of leaving the command center, let alone the hypnointerrogation process itself. It did not trouble him, then or ever; he simply slid out of his sleepsack, confirmed that he had time to keep his appointment, stuck his head out the door and had the Marine stationed there cause breakfast to be fetched.

He did find himself wondering, as he ate, whether any alterations might have been made in his memories or motivations while he slept. But he reasoned, correctly, that the ability to form the question was a reassuring clue, and dismissed the matter. His generation had been the first in a century to grow up trusting its government. Instead he tried to imagine how possession of holy people gave anyone leverage over the Starmind and/or the UN. No rational answer suggested itself.

He reached the command center early, and was admitted by the Ma-

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rines guarding it; Rand and Duncan arrived shortly thereafter. At noon exactly Admiral Cox jaunted in, looking exhausted. It was obvious he had not slept. "Good morning, gentlemen," he said. "I hope this won't prove to be—"

"BILL."

The voice came from everywhere. Jay found it hauntingly familiar, but couldn't pin it down. Then he grasped what it had said, and was suddenly dizzy, a most unfamiliar sensation for a zero-*g* dancer.

Cox was a common name. But this was Admiral *William* Cox. *The* William Cox—former commander of the *Siegfried*! Jay had assumed he was dead. He was used to the company of vips and uips—but he had been drinking coffee and chatting with a legend: the first human being to have set eyes on a Firefly. . . . .

"Yes, Charlie, I'm here," Admiral Cox said quietly.

Jay gasped aloud in shock. This could be no other than Charlie Armstead himself. Shara Drummond's video man, the man who had personally taped the Stardance; co-founder of the first zero-*g* dance company in history; the second Stardancer who ever lived and the spiritual father of Jay's artform. He felt his dizziness turn to nausea.

But he felt infinitely worse when he heard Armstead say, *"I'M SORRY, OLD FRIEND. I HAVE VERY SAD NEWS. . . ."*

CHAPTER 23
Somewhere North of the Ecliptic
26 February 2065

Eva woke hard, feeling every one of her 116 years, tasting each one somewhere on her tongue. Her first coherent thought was that Jeeves must have been nipping at the cooking sherry. He had mutated into a Chinese gorilla and put on a white p-suit. But he still had that quality of shimmering self-effacement. "Good morning, gracious Lady," he said, and bowed. Even the bow was different.

"The hell it is," she replied—and realized they were conversing in Cantonese, a language she had not spoken in forty years. "Speak English."

"This one regrets that he cannot, Lady." There was something wrong with his p-suit speaker; it gave his voice too much treble.

She took several deep breaths, and felt the mists begin to recede. That wasn't Jeeves—or any AI. It was a human being . . . sort of . . . and too dumb to be a servant. And why was he in a p-suit when there was plenty of air in here? Something was badly wrong.

She played back memory. The last thing she could recall was asking Fat Humphrey what he wanted from room service. She looked around. This was not part of Fat's suite—or anywhere in the Shimizu. It looked more like a construction barracks, unpainted metal and visible joins. She and this Cantonese thug were alone here. There didn't appear to be even any potential furniture—not so much as a sleepsack. No wonder her neck ached so badly: she had been nodding in time with her breathing for . . . God knew how long. Hours, at least. Her

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chest hurt, too. In fact, her everything hurt.

Well, some phrases she knew in over a dozen languages. "Where am I? Where are my friends?"

"Lady, this one is too ignorant to be questioned. His instructions are to offer you nourishment, and then convey you to his master."

"Who is your master? You can't be *that* ignorant."

"That is not for this one to say, gracious Lady."

She decided asking him his name would be a waste of time. A tag line from an ancient comedy series flitted through her mind: *He's from Barcelona, you know.* "Skip the nourishment. Can you show me to the washroom?"

That turned out to be something he could handle, thank God. It was down a short corridor from what she was getting through her head was her cell. The Cantonese minder never took his eyes from her, and though he wore no visible weapons something about his bearing said he didn't really need any. She understood now that he wore a p-suit so that he could use sleepy gas on her if he felt he needed to.

As soon as the door sealed behind her, she tried to empty her mind of everything but the question: *Reb, are you alive? Are you here?*

Nothing came back. She thought she might have detected something like a carrier wave, a power hum, but there was no signal. And it might have been wishful thinking. Reb had only been tutoring her in this empathic sensitivity stuff for a couple of months, and her progress had been frustratingly slow. She tried "tuning in on" Meiya and then Humphrey, but was surprised to achieve no better results. She was on her own.

Well, she had a century and more of practice.

Bladder empty and face washed, she looked about the horrid little cubicle for a useful weapon. The facecloth seemed to exhaust the possibilities. She gave up and left. Her self-effacing jailer was a discreet distance down the passageway, and quite alert.

"All right, Marmaduke: take me to your leader." She spoke in English, but he seemed to take her meaning. He led the way—but jaunted backwards, so that his eyes rarely left her.

She memorized the route, and kept her eyes open along the way. This pressure felt *bigger* than a ship, somehow. Indefinable subconscious clues told her it was something more like the Shimizu or Top Step: a massive habitat. More like Top Step in the old days: thrown together, rough carpentry, baldly functional. She also got the impression he was taking her by the back way. They passed few people, and once when they did, he and the others had bristled at each other like challenging cats in passing. She filed the observation away.

The room he led her to reminded her a little of her own suite in the Shimizu. Spartan simplicity—but expensive simplicity. She grew a chair and shaped it to suit her. "You may leave me," she said.

He grimaced. "This one regrets that he cannot, Lady. But he will cease to intrude." With that, he...

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became a piece of furniture. It was like a robot powering down; suddenly he wasn't there any more, except in potential. She tried to catch him breathing, but to her wry amusement she found she could not keep her eyes on him for more than a few seconds; they slid off. She gave up, studied the right arm of her chair, and ordered strong black tea.

She was intrigued to notice that it appeared to arrive under its own power, herded not by microbots but by invisible nanobots. Rough carpentry, yes . . . but state of the art technology.

As she took the first sip, the door sighed open and Chen Ling Ho entered. The Cantonese powered back up and came to attention.

"You could have just asked," she said. "Two of my marriages were elopements."

Chen smiled. It struck her that that was his only response. Almost any other man she had ever known would have felt obliged to make a clever comeback. He made some signal she didn't quite catch, and the guard left, in a wide, fuel-wasting arc to avoid passing between them.

When the door had slid shut behind him, Chen spoke in Mandarin. "Sun Tzu—privacy!"

"Yes, Highness," his AI replied in the same language.

"There," Chen continued in English. "We now have total privacy. But very little time." A chair came to him and enfolded him, and a globe of water found his hand. "I am sorry you were caught up in this, Eva. I would have had it otherwise."

"Where are Reb and the others? For that matter, where the hell are *we?*"

"*Tenshin* Hawkins and his friends are sleeping presently." He sipped his water delicately, and pursed his lips in approval. "Your second question has many answers. We are in an elongated polar orbit, high above the ecliptic, in a region of space where neither the United Nations nor the Starmind could find us, even if they were looking. This pressure itself is many things. Fortress. Laboratory. School. Flagship. My home away from home."

"Is 'prison' in there somewhere?" she asked. "Or can I go home now?"

He failed to hear the question. "Specifically, we are in my quarters, which I invite you to share."

"Damned rude invitation: I hurt all over. Don't you know any better than to subject spacers to high *gs?*"

"There was a regrettable need for speed and stealth," he said. "All possible care was taken: military antiacceleration technology was employed. Happily, you all survived."

"But in what condition? The others should have woken before me, they're all younger."

"But they left Terra behind much longer ago. Their journey was actually more arduous than yours. But do not worry: I am told that their health is excellent."

"Then when will they wake up?"

He sighed. "I do not envision that occurring, I'm afraid."

She set her jaw. "Ling, quit dancing and spit it out. What's going on?"

"You will recall the economic summit conference in the Shimizu last

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month?"

"Let me see . . . the one we almost got killed during, or am I thinking of some other one?"

He ignored the sarcasm. "We five have managed to repair our relationship for the time being, at least, and are now about to destroy the Starmind and overthrow the United Nations."

Eva Hoffman had known more than a few power-mad men and women in her lifetime, including some who were quite successful at it. Had any of them made such a statement, she would have laughed, or at least wanted to. From the lips of Chen Ling Ho the words were blood-curdling. No flip response was thinkable. "My God. . . ." she whispered, horror-struck.

"We hope to create the first rational planetary government," Chen went on conversationally, " . . . rather along lines K'ung Fu-Tzu might have approved of, I think. But it scarcely matters. The point is that once the Starmind is annihilated, any mistakes humanity makes will be its own."

REB! For God's sake, WAKE UP!

Just the barest hint of response, like a man turning restlessly in a deep sleep.

"Ling, for the love of Christ, humanity can't *make it* without the Starmind, not any more, you know that!"

"Precisely why the Starmind must die. The riches it showers on us are like welfare checks: they demean, and degrade, and diminish us. Stardancer benevolence has already evolved us from wolves to sheep, from roaring killer apes to chattering monkeys, in three generations. This trend *must* be reversed, before the inevitable day comes when the Fireflies return. The transition will be painful—but we will make it by our own efforts, as free human beings, or die trying."

"You really think you can kill every Stardancer in the Solar System? *How?*"

He frowned, and chose his words carefully "Before I can answer that, Eva, I must ascertain your status. I have stated my intentions. Three options are open to you: you can be friend, foe or neutral."

"Nice of you to offer the third choice," she said.

"Yes it is. But if you choose it, I cannot answer your question, or any other of a strategic or tactical nature. In that event I will sequester you here, in reasonable comfort but complete ignorance, and release you in your own custody when events have resolved. On the order of three months from now."

She noticed that he did not say, "on the *close* order of" and grimaced. "I assume foes don't get briefed either."

"On the contrary," he said. "If you tell me that you oppose me, I will answer any questions you have. You have been an intimate companion to me, Eva: I would wish your death to be as agreeable as possible."

Reb, wake UP! Rise and shine! Dammit, you're gonna wet the bed!

"I see. And if I claim friendship?"

"You get it," he said simply. "After this is over, you can have the Shimizu for a gift if you like. It lies within my fief."

"And you'll take my word."

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"Eva, I know when you are lying."

"How long do I have to think it over?"

"As long as you wish. But in ten minutes I must leave here to begin the attack, and I will be unable to return for at least twenty-four hours. If you wish to witness history as it is happening, at my side, you must choose to be my friend before I leave this room." He swiveled his chair away from her and began scanning a readout of figures in no alphabet she knew, politely giving her space to think it through.

The trouble was, she thought, the canny little son of a bitch probably *would* know if she lied. That was bad, very bad, for she had to oppose him—*had to*—and dared not even hint why. After 116 weary years and countless flirtations, death had come for her at last, was a matter of minutes away. She was shocked by how much that realization hurt—but even a newfound fear of extinction was of less importance than the awful responsibility she *must* now discharge before she died.

Why me? she thought—and smothered the thought savagely. That was exactly the kind of self-indulgence she could no longer afford. Instead she made her limbs relax, took control of her breathing, and forced herself to remember the words Reb had once told her.

"It's a state of mind more than anything else, Eva. Telepathic sensitivity is largely a matter of shoveling the shit out of the communications room. Try and remember what it was like when one of your babies cried in the night and woke you. There is no 'you' at such a moment, no ego, no identity, no fear, no viewpoint . . . only the need, and the feeling of it, and the will to serve it, to soothe the pain at all costs."

She kept measuring her breath, felt her anxiety begin to diminish. She had not meditated with any regularity since the 1970s, but it seemed to be one of those riding-a-bicycle things. Perhaps it is true that it becomes easier to surrender the ego at the point of death, when you finally admit that you cannot keep it forever anyway. Eva soon felt herself going further away from the world than usual, or perhaps closer to it—climbing to a higher place, or perhaps it was descending to a deeper level, though neither term meant anything in zero gravity—went *beyond*, achieving a selflessness she had only been granted a few times in all her years, for fleeting moments.

With it came a wordless clarity, a focused four-dimensional seeing. Dualities of all kinds became as obsolete as up and down: within/without, self/not-self, good/bad, life/death.

She now knew exactly where Reb and Meiya and Fat Humphrey were: how far away, and in which direction. There was another sleeping adept here in this pressure, too, one she did not know. Their consciousnesses were like fireflies—not the mighty aliens but the feeble terrestrial kind, glowing like embers and dancing mindlessly in the dark. She called out to them. Each resonated to her mental touch, but none responded. They

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could not "hear" her, and she could not wake them.

There was no help here. She must cope alone.

She let herself return to her body.

She had forgotten how weary and frightened and angry it was. From a purely selfish point of view, dying didn't seem like such a terrible idea. Chen was still scanning what looked like the same screenful of gibberish.

"How long have I got?" she asked.

He checked his time. "Another six minutes before I must leave."

No more time at all. "Chen Ling Ho, I oppose you with all my heart."

He closed his eyes for a moment, and inhaled sharply through his nose. "That is regrettable," he said sadly. "As you wish. I will tell you as much as I can before I must go: any questions you still have can be answered by Sun-Tzu."

"How can you possibly kill a quarter of a million undetectable people in free space?"

"Do you remember the terrorist bombing of a shipment of Symbiote from Titan, some forty-five years ago?"

"Sure—your father did it. But that was a traveling ocean, constantly announcing its position. What's that got to—"

"This will go faster if you reserve your objections. My esteemed father Chen Hsi Feng was acting in accordance with a plan devised by his noble father, Chen Ten Li. His intent was not merely to destroy Symbiote, but to discreetly secure a large sample of it for analysis. Fine control of the explosive caused the Symbiote mass to calve in a predictable pattern. While all eyes fixed in horror on the destruction, then turned Earthward in search of its source, a stealthed ship was waiting quietly in the path of one of the largest fragments.

"My father was assassinated by a Stardancer trainee, but the conspiracy he had dedicated his life to lives on. That sample has been studied intensively ever since. We now know how to grow a pale white variant which does everything Symbiote does *except* confer telepathy. It has been further altered so that it requires regular large doses of a chemical which does not occur naturally in space to stay alive. One as astute as yourself will immediately appreciate that it is therefore now possible, for the first time, to create a Symbiote-equipped army which will stay loyal. Starhunters, we call them. Among other things, this base we're in now is to Starhunters what Top Step is to Stardancers."

In spite of herself, Eva objected. "You can't possibly have raised up an army large enough to threaten the Starmind, not in secret. The head-start they've had, the way they breed, the motivations, you can't possibly offer a recruit—I just don't believe it."

He was nodding. "And since our troops must use radio or laser, limited to lightspeed, our communications and coordination are inherently inferior to telepathy, a crippling disadvantage. You are quite correct: we could never seriously threaten the Starmind with infantry, even though

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Starhunters are heavily armed and Stardancers are not. The Starhunters are not intended to kill the Starmind. They are chiefly intended to conquer the United Nations Space Command, and thus the world. Who rules High Orbit rules Terra."

"And what is the Starmind going to be doing at the time?"

"Running for their lives, the few left alive. If they are intelligent enough to keep running right out of the Solar System, a handful of them may live to circle some other star—and good riddance to them, for they can never return. Do you recall how the Symbiote mass was bombed?"

She thought hard. Forty years ago, she had read an eyewitness account by a Stardancer named Rain M'Cloud, who before entering Symbiosis had killed Ling Ho's father to avenge the bombing. Eva seemed to recall there'd been something uniquely horrid about the method of delivery....

She felt a thrill of horror as the memory surfaced. "A nanobomb. Concealed in a kiss."

"It worked well—and close study of Symbiote has suggested many improvements. For the last forty-five years, we have been seeding the entire Solar System with similar bombs, self-replicating at viral speed, self-powered, absolutely undetectible. They ride the solar wind, seek out red Symbiote, home, burrow in and hide. They've been spreading through space like a fine mist for forty-five years. Stardancers breed like rabbits. Statistical analysis indicates that by now, some 90 to 95 percent of the Starmind has come into physical contact with either a bomb-spore, or another infected Stardancer."

For a moment she thought her old heart would literally stop. This was what she had always imagined that would feel like. "Radio trigger?" she managed to say.

"Relays all over the System," he agreed, "About an hour from now I will broadcast a master triggering signal from here. At the moment named in that signal, some six hours later, every relay will begin sending the destruct code at once. Maximum possible warning due to lightspeed lag should not exceed one minute anywhere in the System."

"Trillions of dollars," she murmured dizzily. "To murder angels."

"It could not have been done undetected in anything but the wild-growth economy the Starmind gave us," he admitted. "So in the end they have served a useful purpose."

"Some of them will survive," she said fiercely, and felt something tear in her chest. She ignored the pain. "They'll come for you—they're good at nanotech, they'll find a way."

"Quite possibly," he agreed. "That is why we have kidnapped *Tenshin* Hawkins and his friends, and every other human telepathic adept we could locate. Enslaved by drugs, I believe they will function as excellent Stardancer detectors. Is there anything else you wish to know, Eva?"

She was silent, concentrating on listening to her heart, willing it to keep beating.

"Is there any other last favor I can

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grant you, in the name of our friendship? I fear time is short."

Was there any chance at all that the truth might change his mind? She had no other cards to play.

No, none. She remembered a fictional god she had read of once, called Crazy Eddie, worshipped with awe because in time of crisis he invariably incarnated in a position of responsibility and did the worst possible thing from the best motives. There were usually just enough survivors to perpetuate his memory. It was proverbially pointless to reason with Crazy Eddie. . . .

"I . . . I'd like an hour alone to compose myself," she said.

"Done," he said. "Sun-Tzu!"

"Yes, Highness?"

"Ms. Hoffman is not to leave that chair, nor this room." The chair's seatbelt locked with an audible click. "She is not to communicate with any person or persons outside this room. One hour from now I want you to kill her painlessly. She may command you to shorten that deadline, but not extend it. You may answer any questions she has, and serve her in any way that does not conflict with these instructions. Acknowledge."

"Program loaded, Highness."

He pushed his own chair away and bowed, a full formal salute of farewell. "Goodbye, Eva. I'm sorry you will not share my joy."

Then he bowed again, quickly. Her tea-bulb missed his head by an inch, ruptured on the unpadded bulkhead behind him and splattered his back with hot tea. When he straightened, she was giving him the finger.

His expression did not change. He left.

Pain nagged at her attention, but she had long ago learned to bypass pain. She could still dimly sense Reb and the others; a ghost of the seventh sense with which she had perceived them earlier was still with her, like a ghostly heads-up display on her mind's eye. There was a no point in entering deep meditation and trying to wake them again. She had no assets she had lacked the last time she'd tried, was weaker if anything, and the medical technology keeping them stupified was sure to be foolproof.

She was going to have to think her *way out of this. Or fail and die.*

God damn it, I have not endured all these years of bullshit to become the greatest failure of all time!

And with that, an idea came to her. It was only a possibility, and a long shot at that, but it was infinitely better than nothing.

She thought it through carefully, with the slow, intense deliberation of a freezing man with a single match planning the building of his fire. She built event-trees in her mind, assigned probabilities and risks, prepared contingencies, rechecked every calculation. Finally she felt she was ready.

Assuming that she was right, and did in fact possess a match. . . .

She checked her pocket, and found her personal wafer was missing. She hoped that was a good sign.

Well, I'm not getting any younger.

"Jeeves!" she said.

He shimmered into existence.

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"Yes, Madam?"

Chen Ling Ho had cherished the hope that she would agree he was Alexander the Great and accept the role of emperor's companion; naturally he would have installed her AI online in case he won her over. He would remove the wafer again after she was dead and his war was over. That much had made psychological sense. What had worried her was a matter of semantics. Was an AI a "person"—in the opinion of another AI? And if so, since AIs were effectively everywhere, was Jeeves a person "outside this room"?

She was still alive. Step one accomplished. Now to push the envelope.

"Jeeves, is Rild on-line?"

If the answer was no, Sun-Tzu would not know who Rild was, and might kill her out of caution, just in case this Rild was a "person." And Eva thought it likely the answer would be no.

Chen's holographic gear was excellent; Jeeves became discreetly pained. "Yes, Madam. He has been under constant interrogation since our arrival in this pressure."

Good. Then Sun-Tzu was aware of Rild, and classified him as "not-a-person-outside-this-room."

"Rild, can you hear me?"

Reb had long ago given Eva access to all but the most personal levels of Rild; she was privileged to summon him. The question was, did he have bytes to spare? Or did the software interrogating him tie up too much of his capacity?"

"Yes, Eva," Rild's soft voice said.

She felt like she was tap-dancing on a high wire in terrestrial gravity. Balanced in her hand were all the eggs there were, or ever would be. She began breathing in slow rhythm, composing herself, reaching again for the wordless timeless Evaless place. "Do you have some way to wake Reb?"

The answer came from far away, down a long tunnel. "Yes. A posthypnotic trigger."

Causing a person to be awakened is not communication. "Do it," she murmured, and her eyes rolled up.

This communication, Sun-Tzu was not equipped to monitor. . . .

Reb was there waiting for her, awake, untroubled, numinous. His serenity helped calm her, eased her fear, brought them closer together.

She merged with him. She became him, and he her. For the first time in her life she sensed what it might be like to be a Stardancer. She had always wondered why beings who expected to live for centuries did not fear death *more* than a human; now she understood. It was not the brain that mattered, nor the mind that invested it, but the energy that wore both like a series of intricate disguises for a time and then became something else. She had dimly known this for a long time; now she surrendered to it.

She *felt* the entire Starmind, all around her, heard its chorus echo in the Solar System, grasped its quarter-million-member dance in its entirety, from the orbit of Mercury to the furthest fringes of the Oort Cloud where the comets winter.

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And when that happened, Reb knew all that she knew, simply and effortlessly. And she in turn knew what he knew, which was all that the Starmind knew. Well over 99 percent of that information she would never get to integrate, but she did have time to perceive certain essentials.

Such as: nanotechnological booby-trapping is a game that two can play. And: some nanobombs can be triggered, not by radio signal, but by biting a simple code on the back of one's tongue. And: her great grand-daughter Charlotte in Toronto was going to recover. And: Reb loved her, and everything was going to be OK now. And finally: things are worth what *they cost, and death is a small coin.*

She even had time, in those final nanoseconds, to grasp the full extent of the cosmic joke the Universe had played on her, and to begin to smile.

Then she and Reb and all the other atoms in and of Chen's flagship were converted to a rapidly expanding perfect sphere of plasma, the color of a Stardancer.

Different conditions obtained on Terra; at the same instant, the corresponding base in North China began turning into a large white mushroom cloud the color of a Starhunter.

CHAPTER 24

Noteworthy Events in March, 2065:

—Military mop-up of the rebel forces went into high gear, spearheaded in space by Admiral Cox and on the ground by General Chang of a mortified China; after the first week, loss of life was nominal. Doubtless many conspirators were missed . . . but they were not free for long. Some 93 percent of the relay trigger stations in the Solar System were located and destroyed, although it was apparent that all those who had known the trigger code had died in the same instant.

—After lengthy consultation with the Starmind, the UN high command elected to delete all mention of a plague of triggerable nanobombs in space from its report to the public. This had the effect of making the Rebellion of the Group of Five appear a desperate, doomed kamikaze affair rather than a narrowly-averted coup. Despite—or perhaps because of—its irrationality, the story played.

—The media went into delighted *spasm, like sharks dropped into a fish* farm. Old-timers for whom the business had lost something when people stopped having wars wept openly. The Sacrifice of the Adepts passed almost instantly into fiction—the cronkites and riveras had it to themselves for nearly a week before the first movie and novelization could be released, and then the floodgates really opened. The job of massaging the legend into a pleasing shape began. The performing arts, oddly, did not seem to take to the new subject: most of them already had funded work under way, with more upbeat themes.

—The board of directors of the Shimizu Hotel appointed a new manager and a new PR chief. A special monument was installed in the Grand Foyer, to honor their predecessors, who had bravely sacrificed themselves in a vain effort to ensure the security of guests. In return for keeping their faces straight at the dedica-

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tion of this monument, and their mouths shut forever after, co-Artistic Directors Rand Porter and Jay Sasaki received lucrative new contracts terminable only by them. Each obtained an ironclad artistic control clause.

—The board of directors of the Starseed Foundation announced that Top Step would suspend operations while replacements were sought for its key personnel. The current three classes would graduate, those who made it through, but it would be at least four months before any new Postulants would be lifted to orbit. During the month of downtime, Top Step personnel would be busy dealing with the arrival from Titan of the largest mass of fresh Symbiote ever shipped, a truly stupendous tonnage intended to meet the next fifty years of anticipated demand.

—Rhea Paixao and the group with which she had been Trance-dancing two days a week learned belatedly that Manuel Brava had been one of The Martyred Bodhisattvas, and would not be showing up to join them again. His absence had gone almost unnoted; he had been that sort of man. They all went home and mourned—but the following Saturday night, the group spontaneously reformed on the beach, and Rhea was there. When she got home that morning, she began a novel with a Stardancer as a major character.

—In Yawara, North Queensland, the Yirlandji elders chose another witch woman, and held services for Yarra, who had returned to the Dreamtime after dreaming a mighty dream in a place called China. A song was sung for her by the whole tribe, a song by a dead protegé of hers, called "The Song of High Orbit." And indeed some particles of her may have followed the Songline that far, for all anyone can know.

—All over the Solar System, Starhunters began to die, for lack of a chemical so exotic it was not likely to be found on any ship they could raid. The luckiest of them had nearly a year's supply in their system when the source vanished; some had only weeks. The average ran about three months: the Group of Five had tended to keep its undetectible army on a short leash. As this became clear, some chose to emulate the example of *Tenshin* Reb Hawkins and briefly lit the heavens. Some attempted to surrender to the UN Space Command, and some to Stardancers; the survival rate in the latter category was much higher, but neither agency was really geared up to produce the needed chemical in bulk. Starhunters became the first new addition to the endangered-species list in thirty years.

—People in business suits all over the planet and throughout human space found their adrenal glands flooding as the wills of Chen Ling Ho, Victoria Hathaway, Grijk Krugnk, Imaro Amin and Chatur Birla came into effect; fortunes were made and smashed as the economic machinery of a species began to shift gears.

—Jay Sasaki took a day off from rehearsals, went EVA in a p-suit, and danced a dance he had choreographed in his mind months ago, but never gotten to perform. It was not

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taped or seen by any human or Stardancer's eye, but when he was done, he felt somehow that it had been appreciated. Its working title, the only one it ever received, was "I Love You, Eva." The next day he asked his half-brother to help him Shape a new piece, involving a butterfly with a withered body.

—The Human Genome Project issued its final report to the United Nations; it was formally thanked and ordered to begin dissolving itself. After three-quarters of a century, the massive planetwide research effort had at last succeeded in deciphering all the "pages" of the DNA "book" which made any sense, a truly staggering accomplishment. Among other effects, the day was now in sight when disease would be spoken of only in the past tense.

Still largely unexamined, of course, were all the "garbage pages," the introns, popularly known as "junk DNA": the quite lengthy segments of genetic material (over 93 percent of the total) which, lacking end-begin codes, never express. The prevailing theory was that they represented several million years of accumulated nonlethal errors in transcription. One of the directors of HGP argued passionately before the UN Science Council that there was no such thing as an uninteresting component of DNA, and begged for at least some continued funding. But since introns had no discernible effect on human metabolism, there seemed little urgency—indeed, little point—in studying them, and Council voted to spend the money on more interesting problems.

Noteworthy Events in April, 2065:

—Minions of the Group of Five continued to be identified and taken into custody, on Terra and in space. Admiral William Cox suffered a transient ischemic attack while overseeing the cleanup in space; lateral paralysis proved reversible, and his cognitive and communicative faculties remained unimpaired; nevertheless he was awarded the Terran Medal of Valor and retired on full pay. He took up residence in the Shimizu Hotel in the restored suite whose last guest, Humphrey Pappadopoulos, had enjoyed it so briefly. He chose it because Terra was not visible from its window. In the weeks that followed, there was always at least one Stardancer outside that window, available should he wish company.

—The United Nations Executive Council decreed that henceforth June 22, Solstice Day, would be a global holiday in honor of Reb Hawkins and the other slain Adepts, and would be known as Courage Day. On that day no non-essential work was to be performed and all humans who could possibly do so were requested to take part in a planetwide Hour of Remembrance, scheduled for 3 P.M. Greenwich (thus 7 A.M. in Los Angeles, midnight in Tokyo; only residents of the Pacific islands need lose any sleep to participate.). There was to be no formal ceremony involved; it was asked only that citizens of Terra go outdoors at that time, contemplate the sky, and remember the Adepts. The idea was a popular one.

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—As the media orgasm crescendoed, most of the planet overlooked an offbeat story from New Orleans. It seemed that the area immediately around the French Quarter had fixed itself up, more or less overnight. Centuries of grime vanished; crumbling sidewalks became elegant banquettes again; decayed hulks strengthened themselves and grew ironwork balconies as intricate and lovely as anything in the white part of town, and the statue of Louis Armstrong in Armstrong Park sparkled as it smiled down on a manmade pond whose water was pure enough for human consumption for the first time in a hundred years. Tourists emptied out of the Quarter to stare enviously—and soon were being charged admission. The mayor publicly promised that if the rapturists responsible would come forward, he would give them the keys to the city and hire them to finish the job . . . but there was no response.

—Duncan Iowa was asked by ADs Porter and Sasaki to join Nova Dance Company as an apprentice, the company's first spacer. He proved a diligent pupil, and by the third day he was showing the other dancers tricks.

—Hidalgo Rodriguez's wife Amparo finally succeeded in persuading him that the implement in his magic new home obviously designed as the perfect male urinal was in fact intended to be a sink (Ridiculous! Who did dishes while they moved their bowels?), and that he must use this other silly thing instead. And remember to put the seat down afterward. It made no sense at all to him, but nobody had ever said upward mobility was easy.

—Rand Porter, in private conversation with Charles Armstead, finally brought himself to ask the question, "Were all of you in rapport with Reb and the others when they did it? Did the Starmind feel their deaths?" and was told, "We wished to, but they would not permit it. They shielded us." The answer did not help him sleep any better, but he was glad to know.

—Somewhere above the Ring, the Stardancer Rain M'Cloud was finally brought out of catatonia by the combined ministrations of her children Gemma and Lashi and one Olney Dvorak. At once she began dancing her grief. The others, each separated from her and each other by at least a million kilometers, joined her in ensemble and submitted to her choreography. The rest of the Starmind attended, and resonated. The loved ones of all the other dead Adepts already danced their dances as well. Yet the Starmind as a whole did not grieve, and even among the most grief struck, like Rain, there was an acceptance, a resumption of life, a looking forward. There was much to be done.

—Performing arts groups all across the planet began premiering new works. Not a single one was depressing. An inordinate percentage incorporated images or subtexts of space, or of floating, or of flying.

—Pursuant to the last will and testament of Eva Hoffman, a glass quart bottle of Old Bushmill's Black Bush, nearly half full, was delivered to Jay

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Sasaki. Later that evening, he and Duncan Iowa lightened its mass by another two ounces, and became lovers.

—The estate of Evelyn Martin formally filed suit against the Shimizu Hotel, its board of directors, and citizens Duncan Iowa, Rand Porter and Jay Sasaki, alleging wrongful death, loss of consort, slander and assorted other torts and seeking a million dollars damages from each and every defendant; suit dismissed with prejudice when pretrial software determined that the estate and the deceased had been married for a total of four days and had not seen one another in the ensuing twenty-seven years.

—Rhea Paixao increased her Trance-dancing to three days a week, and began taking her daughter along.

—The Nanotechnology Lab near Top Step announced the commencement of a major new research effort. Its stated purpose was so abstruse that the cronkites gave up and took refuge in repeating the words as if they understood them. No one caught them at it.

—The Right Honorable George Kiku, Undersecretary of Revenue for the United Nations and Assistant Chairman of the Committee on Fiscal Anomalies, took early retirement under his burnout clause, and resumed a long-interrupted study of the guitar. It came back hard, but he took to soaking the fingertips of his left hand in cold tea, and eventually the calluses returned.

—Alert Space Command software noted that an unusually high number of Stardancers were in the close vicinity of Terra, and that many more seemed to be vectoring Earthward. But since it did not classify Stardancers as either threat or navigational hazard it did not notify any human beings.

Noteworthy Events in May, 2065:

—The last Stardancer was successfully disinfected of her submicroscopic bomb, and shielded against reinfection. A misty disk of death still spun about the Sun, but it could now be ignored until it was convenient to clean it up.

—Colly Porter received a vacuum sculpture by courier. It was called "Puffball," and pleased her mightily. Her mother liked it too, and placed it in a prominent place in the living room, beside one by the same sculptor called "Driftglass."

—A dancer named John DeMarco, realizing his dream of a lifetime, was invited to join Toronto Dance Theatre as a principal dancer, largely on the strength of a particularly inspired performance at the Drummond four months earlier. His former artistic director never forgave him for accepting, and made a point of telling him (mendaciously) that she had faked every single orgasm.

—LaToya Dai Woo, Assistant Director of the US Internal Revenue Service, resigned under a cloud having to do with inexplicable anomalies in that year's data; while the antiquated computer system was torn apart and rebuilt, she moved to the Shimizu Hotel and took up recreational sex.

—The New Orleans self-renovation

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phenomenon began occurring in ghettos, slums and eyesores around the planet. One economist calculated that even given the immense cost-effectiveness of nanotechnology, several trillions of dollars had to have been spent by rapturists worldwide. Hardly anyone believed him; he was, after all, an economist.

—Gunter Schmidt finally recovered from the bronchitis which had followed upon his stroll through icewater in Nepal, and succeeded in suing his travel agent into bankruptcy. He then returned to Nepal to catch the May Tiji Festival—and learned on arrival that since the Kali Gandaki had in fact returned, the festival had been declared redundant. The Lo were too busy planting crops.

—Unnoticed by anyone, Admiral Cox slipped out a maintenance airlock and entered Symbiosis. The p-suit he removed in order to do so eventually burned up in the upper atmosphere, flaring as the airtanks went up. Since his bills continued to be paid and his room and AI reported no medical emergency, his absence went unnoted until late June.

—The rising wave of "cheerful art" reached such a crest worldwide that even critics began to notice it. Certain conspiracy-theorists among the media began to smell a rat, and whispered along the E-mail byways of "rapturist conspiracy"—ideally some kind of immense digital fraud. To their annoyance, investigations kept indicating that the money funding all this new art was real. And anonymous. So they went public with the old standbys, thinly-veiled suspicion and unsubstantiated rumor—and would have gone on to entirely baseless allegations in turn, if they hadn't noticed that nobody seemed to be paying the slightest bit of attention to them. Everyone was too busy attending performances that sent them home feeling good.

—The mammoth new mass of Symbiote reached Earth Orbit, was carved into six chunks, and each was inserted into a stable orbit. The reason for subdivision was not known, but it aroused little curiosity. Few humans were of a mind to pester the Starmind with nosey questions these days.

—Colly Porter, having been back on Terra for the recommended three months, returned to High Orbit to spend a month with her father in the Shimizu Hotel. Shortly after her arrival she stated the opinion that hugging was more fun when you could use your legs, too. This caused her father to blush (humans seldom go pale in free fall, but they can still blush), and begin rehearsing a speech he had been meaning to deliver for a couple of years now. But in the end he managed to stall just long enough, and was spared the necessity.

—A peculiar glitch began to show up in automobiles—*all* automobiles, regardless of place or date of manufacture. Changing lanes without signaling at least five seconds in advance appeared to cause total CPU failure. Fortunately, the "crashless crash" safety feature hardwired into the guidance system usually brought the offending vehicle safely to the side of the road. No one claimed credit for

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the innovation, and public opinion split: some attributed it to rapturists, while others blamed a much older, half-forgotten group called "hackers." But the prevailing response of humanity at large was glee, and no one tried too hard to crack the case.

At the end, there, everything seemed to happen at once.

CHAPTER 25
The Dunes East of Provincetown
22 June 2065
Courage Day

"This is a good spot, Mom."

Rhea thought so, too. They were at the ocean shore east of Provincetown, just where the upthrust arm of Cape Cod curls its wrist back toward the mainland. Before them was the sea, next stop Europe; behind them to the west, between them and P-Town, lay kilometers of sand dunes. The weather was perfect, and had been since they had watched the Sun rise together over the Atlantic several hours ago. It was now almost time for the Hour of Remembrance, and she and Colly were just finishing the food they had brought with them from home.

There were few others here, even on his global holiday. There were too many beaches a P-towner could reach without having to walk several kilometers of sand, too many boats available to take them out on the water, especially since the fleet was not fishing today. Nonetheless Rhea had never seen this particular stretch of shore so heavily populated. The idea of Courage Day had caught on.

The spot did not feel crowded; there was no rowdiness; the general mood seemed to be a kind of subdued celebration. People spoke less than usual, and in softer voices; those who listened to music or news did not inflict it on their neighbors; even teenage boys were not horsing around. Rhea suspected things would get more festive later, after the Hour was past, but for the moment there was a kind of solemnity in the air that seemed to call for decorum. It had been a long long time since so many saints had been martyred at once.

"Do you feel like Trancing?" Colly asked.

Rhea looked around. There were a few individuals dancing, but no group had formed as yet. She did not see anyone she knew nearby. "Maybe later, hon. After the Hour."

"OK." Colly liked Trance-dancing well enough, but was not as attached to it as Rhea had become in recent months.

"I'm surprised you have the energy," Rhea added idly. Colly had only been back on Earth for a few days after visiting her father in orbit.

"I know," Colly said. "Me too. Yesterday I was tired as galoonies—but today I feel like Waldo. You know what I mean? Like he must feel. Like, I know I'm weak, but I don't *feel* weak."

It took Rhea a second to get the reference. "Oh, *Waldo*—your new friend in Shimizu. I forgot all about him." Come to think of it, Colly hadn't mentioned him once since her return. "How is Waldo?"

Suddenly Colly was a textbook

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illustration labeled Nonchalance. "OK," she said off-handedly, studying her fingernails. "His frog died, and he likes that dopey classic rock music now, and his teacher says he understands calculus." Beat. "And he said he wants to marry me when we're bigger."

Rhea's heart turned over in her chest. She didn't know whether she wanted to laugh or cry, only that she must do neither out loud. *And so it begins,* she thought. "Oh," she said, with equal casualness. "I'm . . . sorry to hear about his frog."

"Yeah. Hip was cool."

"So, uh . . . what did you tell him? About the marriage thing."

"I said I'd think about it."

"I see. Did that satisfy him for now?"

"I guess." Another pause. "He wanted to kiss me."

Rhea chose her words with care. "How was it?"

Colly had run out of fingernails; she segued smoothly to toenails. "OK, I guess." Suddenly she turned and looked her mother in the eyes. "But honestly, Mom, I don't get what the big deal is."

Rhea refused herself permission to smile. It cost her. "You will, baby," she said solemnly. "You will."

"Yeah, but *when?*"

"You won't miss it," she said. The words made her think of Manuel Brava, and she glanced at her watch-finger. "Hey, it's almost time."

It was about five minutes before the hour. All up and down the beach, conversations were ending, people were sitting up straighter and facing the sea. Boats out on the water killed their engines, and their passengers came out on deck. Rhea felt a sudden pang of loneliness, the kind that a child's presence does not assuage. Holidays are always the worst time for those with no significant other.

"Mom? We're rich now, right?"

The non sequitur made her smile. "No, dear. But we're richer."

"Well . . . can we afford to call space for an hour?"

Automatically Rhea started to do mental arithmetic . . . then abandoned the equation unsolved. Her daughter had sideswiped her for the second time in less than a minute. *"Yes,* Colly! That's a *great* idea! Oh, I hope he's not . . . no, they won't be working in orbit, either." She was already autodialing, half-wishing the car was near so they could have visual too. Space images would have been appropriate during the Hour. Ah well. . . .

Rand answered almost at once. "Hi, Rhea! Is Colly there? Of course she is—hi, princess!"

"Hi, Daddy!" Colly called back.

Rhea adjusted the volume for privacy. "Hi," she said.

"Where are you guys? No, wait—let me guess. Audio only, so you're out in the boonies somewhere. From the sound of the waves, ocean rather than bay side. The Dunes, right?"

How could someone who knew you that well be hundreds of miles away? "That's right."

"Is Uncle Jay around?" Colly asked.

"Right here, cutie," Jay's voice said.

"Hi, Uncle Jay! Hi, Duncan!"

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There was the sound of laughter, then, "Hi, Colly," from Duncan.

Rhea monitored herself to see if Duncan's voice caused any internal fluttering. Nothing. She hoped he and Jay would make a success of it. "Where are you guys, anyway? No wait—let me guess." It couldn't be one of the Solariums: Rand and Jay were celebrities. Somewhere private, with a good view—got it! "You're all in Eva's window, aren't you?"

"Right," Rand said. "As a matter of fact, I think I can see you from here. Wave, Colly."

She looked skyward and did so. "Here I am, Daddy!"

"I see you," he assured her. "You've got mayonnaise on your chin."

She checked—and burst into giggles when she found he was right.

"We're planning to do some damage to the legacy Eva left me, as soon as the Hour is over," Jay said. "I wish I could send you down a snort."

"Me too!" Rhea said. "Look, I know the Hour's almost here. We don't have to talk or anything—but can we all stay online together until it's over?"

"It's something Terrans and spacers should share," Duncan said.

"It was my idea," Colly said proudly.

"And a good one," Rand told her.

"Are you OK, Uncle Jay?" she asked. "Are you sad about Eva?"

His answer was slow in coming. "Let me put it this way, honey," he said at last. "I'm not exactly OK yet—but I know I'm going to be. You know what I mean?"

"I know exactly what you mean," she said solemnly, and Rhea felt a brief stab of guilt. "Daddy, tell him that thing Captain Kirk said."

"Huh?"

"You know, about leaving."

A chuckle. "Oh. Not Captain Kirk, honey: Rahssan Roland Kirk. An Old Millennium jazzman. He once said, " 'Nobody dies. They just leave *here.*' "

There was a pause, and then Jay's voice said, "I think that's true. Thank you, Colly."

"Two minutes," Duncan said.

"It feels like we ought to be *doing* something," Rhea said. "Colly told you we've been Trancing a little, right? Maybe we should all dance or something."

"Well," Jay said, "I figure like this: Reb was Soto Zen. One of his favorite sayings used to be, 'Don't just *do* something—sit there!' Do you guys know how to sit *zazen?* That's what we were thinking of doing."

"Sure," Colly said with just a hint of scorn. "Duncan taught us once. Well, *kukanzen,* not *zazen,* but they're prac'ly the same." She began manipulating sand into an improvised *zafu,* and Rhea followed her lead. She was cautious about exposing her child to organized religion, but Zen did not meet her definitions of a religion. It had no deity, for one thing—but more important, it did not require either killing or converting unbelievers.

"It's OK to get up if you get antsy, Colly," Jay said. "Reb wrote a book once called *Running Jumping Standing Still.* Any of those would be appropriate, I think. Or you can Trance,

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if you like. But let's sit a little at first, at least at the start."

"Sure," she agreed.

"I'm the *Doan* today," Jay said. "The timekeeper. I'll ring a bell three times when the hour strikes, and again when it's over, and we'll all be silent in between, OK?"

"Are you studying Buddhism now, Jay?" Rhea asked.

"Aw, I've been fiddling with it for years. But yeah, I'm getting into it more likely. It's a lot like drinking Black Bush, only cheaper."

Rhea checked her daughter. "No, honey, like this. You don't have to lace your fingers in a *g* field, remember? Left hand on top of right palm, thumbtips just touching."

Colly corrected her *mudra*, and straightened her spine. "Are we supposed to look downward?"

"Technically, yes," Jay said. "But for today I think looking up is OK. There's really no wrong way to do it, if your heart's in the right place. Just follow your breath . . . and remember Eva and Reb and all the Adepts."

"Get ready," Duncan said. "It's almost time."

The beach was hushed, now, save for the omnipresent *whush* of waves. The sky was nearly cloudless, baby blue. Rhea felt an electricity in the air. It was awesome to think that at this moment, all over the world, most of the human race was about to do just what everyone here was doing. Had humanity ever acted with anything like this kind of unanimity before? What a pity it took a tragedy to bring it about. But wasn't that always the way? Nothing brought people together like a good disaster. . . .

"Ting. Ting. Ting," said the phone. Rhea composed herself, drew in a measured breath through her nose—

And the sky turned gold.

Not "gold" in any metaphorical or analogous sense, as one can be said to have "red" hair when it is not really red at all. The whole sky was literally golden, the color of burnished 14-karat gold, the color of the wedding ring Rhea had still not been able to bring herself to remove. It happened all at once, seeming to mushroom outward from several sources like a crystal forming in an instant. It was like a translucent gold roof cast suddenly over the world, shimmering and twinkling, backlit by the Sun.

Everyone on the beach—very nearly everyone alive—gasped, and stared upward in wonder. Rhea found that she and Colly were clutching each other's hands, *mudra* be damned. An indescribable sound began to come from the people on the shore. Rhea had once, many years ago, been caught in a riot, and would carry the memory of that indescribable, unmistakable sound to her grave. This was its opposite: a vocal sharing of awe. Perhaps the Israelites had made such a sound when the Red Sea parted.

Some of it seemed to be coming from the phone. "Can you guys *see* this?" she cried. "It's unbelievable!"

"We see—" Rand began, but she did not get to hear what he saw for some time, because his voice was drowned out by another. It seemed to come from everywhere, yet did

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not have the echoing quality of loudspeaker broadcast; it was as though every AI on the beach had been coopted at once.

"This is Shara Drummond, calling the human race. I need your attention."

Rhea knew that her heart should be racing. Shara Drummond—the first Stardancer! Addressing all mankind directly, for the first time since her original Stardance, sixty-five years ago.

Yet somehow Rhea felt herself growing calmer. She met Colly's eyes . . . and they resumed formal *zazen* posture, side by side, but continued to hold hands.

"I have taken over all data channels and AIs in human space to talk to you, because something unprecedented is about to happen. A radical change. It may seem frightening at first, but I promise you it will be all right, if you do as I ask. The Starmind is here to help you through this . . . but you must do your part, and no one can do it for you. The first thing you must do is get everyone on Terra outdoors, and everyone in Luna onto the surface. I mean everyone. *Essential services personnel, hospital patients, the dying, the housebound, prisoners in solitary, all human beings. If you know of someone trapped indoors, get them outside* now. *And hurry! There is no time to lose. I will tell you what I can—but don't stop to listen if you know of some human who needs help getting outdoors; the information will be repeated many times.*

"A turning point has come in the history of the human race—one set in motion by the Fireflies on the day they came here for the second time, the day of the Stardance. We Stardancers were created in large part to help you through it."

Rhea thought quickly. Thank God Tia Marguerite and Tia Marion were out on Ti' Louie's boat—it was an hour's hard walk back to the car. Everyone else she knew in town was mobile, too. Suddenly she missed Rand so much her stomach hurt. "Are you guys hearing this too?" she murmured.

The phone's LED said the circuit was still open, but there was no reply. She thrust it absently into her breast pocket.

"I'm afraid your life is about to change forever. Your old life is over; a new one is about to begin. I know that will not be welcome news for many of you. No baby wants to be born; they all come out crying. But they stop. I'm afraid you have no more choice in the matter than a baby does: the contractions are beginning, and no power in the Solar System could stop them now. All we of the Starmind can do is see that the birth takes place as smoothly and painlessly as possible. We have sacrificed much to that end . . . but today is not our Courage Day, but yours. I can only ask you to trust in me—and in the Fireflies, who refused to let me die in orbit so many years ago.

"On that day, my planet was like a womb whose fetus is overdue for delivery. Such a fetus grows too large for its environment, begins to pollute its ecosystem with its own waste

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products, begins to degrade its surroundings. In the decades that followed, you—and we, the Starmind—have cooperated to help correct most of the damage to our home planet, using nanotechnology to minimize new wastes and recycle old ones efficiently. The womb is repaired—but it is time for the fetus to leave it behind now."

Rhea did not guess what was coming; it was only a shadowy intuition. But it was enough to make her heart sink. She stared around that perfect beach, that eerie golden sky, as if to memorize it, and clutched Colly's hand. At an answering pressure, she met her daughter's eyes—and found them serene, untroubled.

"It's OK, Mom," she said. "It's Courage Day."

Shara Drummond's voice continued:

"You know that the Fireflies seeded this planet with life. You know that much of what you are is written in your DNA. Some of you may know that large segments of the information encoded there appear to be gibberish, and do not express somatically—the so-called junk DNA. These genetic 'instructions' are never carried out, because they lack the end-begin codes that would activate them.

"In just a few minutes, a kind of telepathic trigger signal will go out from Titan. There is no way to avoid or shield against it: it will be as unstoppable as a neutrino, and faster. Designed by the same beings who designed DNA in the first place, it will insert end-begin codes in certain introns—and switch them on. Everywhere in the Solar System, the nature of human tissue will change, permanently.

"It will become transparent to gravitons. In plain language, it will become immune to gravity."

Rhea moaned.

"Please listen to me and try to be calm. Many of you on Terra may have the idea that what is usually miscalled centrifugal force will send you flying off the planet at high speed. This will not *happen. When you go weightless, the net upward force acting on you will not exceed .003g. Your clothing should suffice to hold you in place; even shoes will probably be enough. Ask your AI if you don't believe me; I'll be releasing it to your control again soon. Nonetheless you will be in free fall, with the usual physiological symptoms most of you know: dizziness, stuffy nose, and so forth.*

"This period will last for perhaps five minutes. Then machines will turn themselves on. There are three of them. One is buried deep in the core of Terra, one at the heart of Luna, and the third at the core of Mars, though no one is there to be affected by it now. Each is designed to generate antigravitons—a special kind of antigravitons which will only *affect altered human tissue.*

The next sentence was delivered slowly, deliberately.

"Like it or not, you will find yourself rising into the sky."

A wordless cry went up all around the beach—doubtless around the planet—a discordant amalgam of clashing emotions. Shara Drummond

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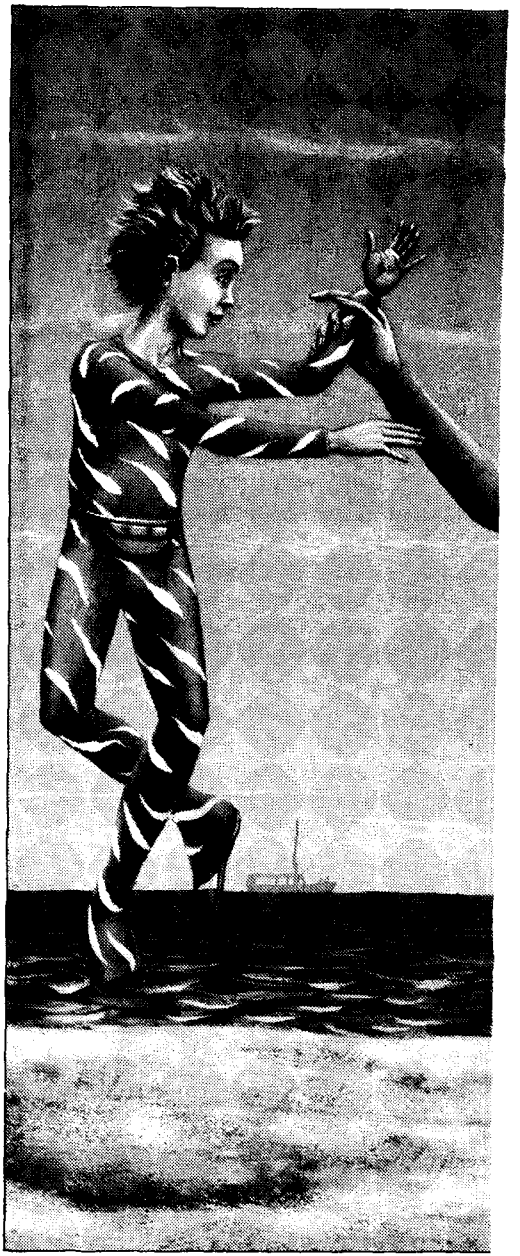
seemed to anticipate that, and waited for it to die down.

"DO NOT FEAR," she said then. *"It is not death that waits for you in the sky, but a new kind of life. You will not freeze or suffocate as you climb, I promise you.*

"For the last sixty-five years, the Starmind has worked at modifying our Symbiote, in preparation for this day. The gold you see in the sky is the variant we have shaped, a variant designed to survive, for a time, at the interface between Terra and space. It cannot come down to you . . . but you will find it waiting for you about five kilometers above the ground, just as the air is getting too thin to breathe. Touch it anywhere, drink it, and it will shape itself to you. It will breathe for you, and bring you higher, changing from gold to red as you leave the atmosphere behind.

"This is why the Adepts made their sacrifice. If the Group of Five had gotten their way, all *of you would have died this day. The Five knew nothing of this, nor could we tell them. Without a Starmind, you would have suffocated as you left the stratosphere—and would not be hearing me now. But thanks to* Tenshin *Reb Hawkins and the others, you will live to reach space.*

"And we the Starmind will be waiting for you. To show you your new world. Your new home. You will be one with us, and we with you, Homo caelestis *forever."*



A vast soundless sound filled the world. Rhea heard it inside her head, as if on headphones. It was music, and

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she even recognized it: something Rand played all the time, something by Brindle whose name she could not recall. But to her tortured imagination it seemed like the Trump of Doom that Christians believed would signal the Rapture. She found that she was clutching Colly to her fiercely, keening without words. The words that raced through her mind were, she knew, probably shared by millions; indeed, they might have been the final thought of most of the humans who had ever died: *Not yet! I wasn't* done *yet!*

It was a protest the Universe had never heeded yet. As she drew in a breath to scream it aloud, Colly spoke against her breast.

"Don't worry, Mom," she said. "I didn't want to come out either, remember?"

Rhea remembered. Colly had been born three weeks overdue. She had stayed stubbornly in the womb until a pitocin drip induced labor and forced her out. And Colly had come to like this world.

"It's OK," Colly insisted. "We're gonna go see Daddy now."

She kept her deathgrip on Colly's shoulders, but pulled back so she could see her face. Colly was smiling. "Can you feel it?" she asked.

With a thrill of something like horror, Rhea felt her weight leaving her. She tried to hang on to it, but could not. Within a minute it was gone completely. Her sinuses began to fill and she felt her face reddening as blood redistributed itself evenly throughout her body. She felt mild dizziness, too. It was just like climb-

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ing to orbit in a shuttle—except that the rest of the world around her continued to observe the law of gravity.

Shara Drummond's message began repeating.

Colly picked up an uneaten apple, held it out and let go. Rhea's body-awareness told her that she was in zero *g*, so persuasively that it was jarring to see the apple fall normally. Colly giggled.

Suddenly she squirmed out of Rhea's grasp, a trick she had perfected at age five. Rhea cried out, but it was too late: Colly had already unfolded her legs from beneath her . . . causing her to rise into the air.

Without thinking, Rhea sprang after her and caught her like a tackler, hugged the child to her. They found themselves about six or seven meters in the air, sinking with the gentle slowness of a feather beneath the weight of their clothes. This high in the air, Shara's repeating message was almost inaudible. Others around them were airborne too. *A convention of Nijinskis,* she thought wildly as she drifted down. *Oh, Jay would love this! And Rand. . . .*

"I wish Dad and Uncle Jay could see this," she said aloud.

Colly was grinning, exhilarated. "Just pay attention," she said. "We can give them an instant replay later."

They landed gently on sand, a few meters west of their takeoff point. With space-trained instincts and Trancer skill, both let their legs absorb the energy of landing, so they did not bounce away again. For a moment they bobbed there together, poised at the very membrane between earth and sky. They could hear Shara's voice clearly again, now that they were close to the earth—and many competing sounds, too. Some people were screaming, some were laughing, some were yelling contradictory advice; some were flailing helplessly in the air, trying vainly to swim back to earth. And some were finding out how high they could jump. Out on the sea she could see people leaping higher than their masts, moving lazily in the air, like drowners in reverse.

"Let's Trance, Mom," Colly said. "We can do it for real, now."

Rhea had a sudden vivid memory of Manuel Brava, the night she had Trance-danced for the first time.

Be ready, he had said. *It's gonna be good.*

And this was the Hour of his Remembrance. . . .

Somewhere in Rhea's heart, something gave way. Without regret, she closed the book that was her life . . . and began a new one. "All right, Colly." She released her embrace. "Take my hand, though, OK?"

"Sure," Colly said. "Here we go!"

They leaped together.

A few minutes later, Rhea admitted to herself that she was having fun. More fun than she had had in a long time. It was a little like trampolining or bungee-jumping in ultraslow motion. It was very much like dreams she had been having all her life. It was, in literal reality, what Trancing had always felt like, except that the moments of breathless exhilaration were not fleeting and transient.

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Some others around her were also moving in the characteristic flowing movements of Trance-dance, now; she and Colly were not the only Trancers here. Out on the sea, some people were walking on water, with exaggerated steps; she could just hear them laughing.

"—You OK?" Rand's voice said suddenly from her breast pocket. "Rhea! Colly! Can you hear me? Dammit, are you OK?"

He sounded half out of his mind with worry. Rhea took the phone out of her pocket. "We're fine, darling. Hang on—I think we're coming for a visit."

"What the hell do you mean? What's going on down there?"

"Didn't you hear Shara up there?"

"Yeah, but it didn't make much sense. She told us to go EVA, find some Symbiote, and take off our p-suits. But what about you? She said something crazy about immunity to gravity and gold Symbiote."

"That's right. We're about . . . oh, I'd guess twenty meters above ground right now. It looks like you win: Colly and I are coming to space after all."

"Oh God—you'll freeze, before you can reach the Symbiote!"

"I don't think so," she said. "It's warmer than it should be down here. I think that gold Symbiote is having some kind of lens effect. They've had a long time to think this through."

There was silence on the line. The first to fully absorb the news was Jay. He began to laugh with joy. "Oh, Eva!" he cried, "what a glorious joke on you! Oh, how *wonderful!*"

"What do you mean, Jay?" Rhea asked.

"I get it now—I see it—I know why she wanted to die—and why she was dragging her feet—the stubborn old biddy was holding out for *meaning* . . . and she got it, bless her selfish heart—damn, she got the prize—oh, I'll bet she died smiling—"

"I don't understand," Rhea said. "Rewind and start over—slower."

"I'll try. Look, at age one hundred, Eva was done with life. So she went into fifteen years of life review, and found no *meaning* in anything she'd done. During a century of living as hard as she knew how, Eva converted *X* cubic tonnes of food and water into excrement and offspring; she pushed *Y* megabucks from one imaginary place to another; she experienced *Z* increments of pleasure or pain; once done, she could find no real significance in any of it. So her last hope for meaning was her death: she spent sixteen years hoping, irrationally, to find a meaningful death, an opportunity to give up her life *for* something. That's why she kept postponing her suicide for so long—why, even after she gave up and made up her mind to die, she stalled long enough to let Reb arrive, and give her a convincing reason to wait just a little longer. The reason was: to live to see this historic day."

"It's a shame she missed it, then," Colly said.

"No, that's the best part, don't you see?" Jay said. "It is a shame she didn't live to see it with her own eyes, sure. But I'm sure she got to see it through the Starmind's eyes before she

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died—and more important, she got something even better. She got what she'd wanted in the first place, what she'd already given up on when Reb told her about today: a meaningful death. Think about it: how many humans—how many creatures, in the wide Universe—had ever been privileged to sacrifice their lives to save *two* intelligent *species?"*

Colly was the first to see it. "Wow, yeah," she said wonderingly. "If it hadn't been for her and Reb and the Adepts, all the Stardancers would have got killed, and there wouldn't be any of that gold simmy-oat up there waiting for us. All us people would have died today."

"She got the most meaningful death there ever was," Rhea said. She giggled suddenly. "Every damn time humanity goes through some kind of birthing, there seems to be an Eve around."

"Are you *sure* you're OK?" Rand asked. "You sound sort of giddy."

She laughed out loud. "Let's just say a great weight has been lifted from my shoulders. We don't have to be apart any more, baby. Not ever again. Hang in there—we'll be along directly."

"What should I do?" he cried, his voice agonized.

"What Shara said. And don't be afraid. I'm not. I was, but I'm not anymore. It's gonna be *good."*

"But—"

"Go ahead. I've got to hang up now, I don't want to miss this. We'll be there soon, love." She let go of the phone, and watched it fall away.

She and Colly were slowly moving away from the ocean, into the dunes. With each leap they came down farther to the west, for the Earth went on without them all around them. They were sweating with exertion, now, and the sweat behaved the way it did in free fall, as content to drip up as down. In her mind's eye Rhea saw the whole human race doing this. Hovering. Tottering on the brink. Trembling on the verge.

The ground was coming up again. You didn't even have to look when you could hear Shara clearly again, it was time to prepare for your landing.

"Colly!" she cried. "Want to go for the big one?"

"Sure," her daughter said.

Rhea began undoing her clothing. Colly got the idea at once and skinned out of her own clothes. They let go, watched their clothes fall. This time, when they hit the Earth and rebounded, they kept on rising.

They kept dancing for awhile as they rose, but the view was simply too distracting to concentrate; after a time they stopped moving in space and just gawked, letting the wind do with them as it would, turning end over end. The Earth moved slowly and majestically beneath them. Soon Provincetown was below them. It was weird, inexpressibly weird, to see P-town with hardly a soul on the streets. The beaches were full of hopping fleas, and the sky was starting to fill with naked people. It reminded Rhea of news footage of hot-air-balloon regattas in the desert.

"Look," Colly said, pointing. "There's our old house."

Rhea saw it. For a moment it filled

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her heart, and called her back. Her beloved widow's walk. Below that, the tower room in which her unfinished novel waited, and below that the bedroom into which she had been born. Kicking and screaming.

"Goodbye," she said to it. "I'll never forget you."

"'Course not," Colly said. "Me either."

Suddenly they were rising faster, as though propelled by a great wind from below. It felt surprisingly like surfing vertically.

"Hang on," Rhea cried.

"Here we come, Daddy!" Colly called.

And they rose up forever, going for the gold.

EPILOGUE
High Earth Orbit
22 July 2065

It did not go totally smoothly, of course. Human beings were involved; at least some chaos and tragedy had to result.

But there never were more than the two choices: evolve or die.

Perhaps it need not have been done as it was, by surprise. Perhaps humanity, forewarned and prepared, might have agreed to leave its ancestral womb forever, peacefully and without panic. The decision not to risk it was irrevocably made on the day the original Six entered Symbiosis and founded the Starmind, back at the turn of the millennium, back when most of the human race was hungry and poor, and pessimism was still the hallmark of intelligence. Once Charlie Armstead elected to leave Courage Day out of the report he sent back to humanity from Saturn in the historic Titan Transmission, it was too late to turn back: the Starmind was committed to secrecy.

If you could somehow establish telepathic contact with a human fetus in its ninth month . . . would it be a kindness for you to tell it everything you know of the birth trauma to come? Would it benefit from the foreknowledge—or panic, jam the birth canal, and kill itself and its mother? After all, less than 1 percent of the race ever voluntarily chose to go to Top Step and become Stardancers. Being human is a hard habit to break. Shara Drummond, Charlie Armstead and their companions believed—all the Starmind still believes—that humanity might well have died rather than leave Earth, given the choice. So they did not give it the choice until the last possible instant . . . and spent sixty-five years secretly preparing it for that instant.

This cost the Starmind much ethical anguish over the ensuing years —and sharp tragedy at the eleventh hour—but right up until the Day of Courage, the overwhelming consensus of the massed brains of the Starmind was that the stakes were just too high to permit any risks. One of the few concrete facts that the Fireflies told the Starmind before they left us to work out our own destiny is that *Homo sapiens* is at least the *third* sentient race to be raised up in this Solar System.

The first sentient race ("sentient" defined as "capable of art") lived eons ago, on a planet some call Lucifer,

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whose shattered remains are now known as the Asteroid Belt.

The second such race appears to have been somewhat more advanced: they "merely" blew the atmosphere off the next closest planet to the Sun, Mars. But they are just as dead.

We appear to have squeaked through to the finish line.

Had we, too, failed our most final of exams . . . well, there hangs Venus, within the habitable zone, its reducing atmosphere ready to collapse into a viable biosphere at a chemical nudge. . . .

Perhaps when I was a human fetus, I would have consented to be born. But I am glad, all things considered, that I wasn't consulted.

Volumes larger than this one could be—are being—written about the chaotic events of the hours and days that followed the Hour of Remembrance, the countless millions of varying human reactions to Shara Drummond's call.

No volume however large could describe what happened when over ten billion minds entered telepathic symphysis in a single great cascading wave, nor will I try even to hint at it here. Suffice it to say that only the presence of a quarter of a million trained and prepared telepaths made it possible at all. Symbiosis is profoundly disorienting in its first onset, and some find it terrifying—Stardancer Postulants used to spend three months in Top Step preparing themselves for the transition. But human beings are tough when they have to be, and we had to be.

Even now, a month later, the integration process is still ongoing. It might not be too inaccurate to say that the new HyperStarmind has achieved consciousness, and is working—slowly!—toward awareness.

Despite the very best efforts of a quarter of a million linked minds planning for over half a century, a little more than 2 percent of humanity perished in the mass transcendence to *Homo caelestis,* most through stubbornness but some from sheer stupidity. No telepathic entity can take lightly the deaths of so many millions of souls—especially needless deaths, on the very verge of immortality. But at least their surviving loved ones *know* with utter certainty that everything possible was done to save them; there is mourning for them in the Starmind today, but no recrimination. Cells die whenever a baby is born; it is no one's fault. Balancing the sorrow to some extent is the joy of all those who love an autistic or retarded or catatonic or mute person—for now they can communicate with their loved ones on a level far deeper than words could ever have reached.

Approximately one half of 1 percent of humanity were unaffected by the telepathic tocsin from Titan or the subsequent flood of antigravitons: genetic defectives whose DNA had sustained too many nonexpressing mutations over the millennia, whose introns were fatally damaged despite massive redundancy in the coding. But nearly 90 percent of those eventually reached space and joined the Starmind too . . . for there were suddenly spacecraft to spare.

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And a little over 5 percent of the human race flatly and stubbornly refused to go—improvising an astonishing variety of desperate methods to remain near the Earth's surface, to remain only human. Within a month, however, their number had shrunk from 5 percent of the former total to about 2.

The present population of Terra, then, consists of a little more than two hundred and fifty million people—on a planet with wealth and technology and room enough for more than ten billion. Most of them are wearing weights. You are one of them, or you would not be reading this. And the odds are that despite your new wealth and lebensraum you are lonely and/or hurt and/or angry and/or afraid.

You do not have to be any of those things. If you insist on staying on Earth, your life need not be hard: we will continue to beam down power and programs for your nanoassemblers, and other things you will need—or you can make your own way as your forebears did, if that pleases you.

But you do not have to stay.

The golden sky of Earth is blue once more—but there is plenty of red Symbiote in orbit. And even now, Terra holds more than enough resources to send you to join us. Even if you are one of the rare genetic unfortunates—and if you are, we have the resources to heal your introns, once you enter Symbiosis.

That is why I am writing this.

All you have to do is find a phone. Shara Drummond is accepting collect calls, and will tell you how to reach the nearest functioning spacecraft. We're waiting for you.

Some of the oldest Chinese legends speak of a mysterious "edible gold," one taste of which confers immortality. It seems unlikely the ancient Chinese could have had any direct knowledge of the Fireflies or of Symbiote—it may simply be that, given enough time, *any* prophecy will eventually come true.

For millions of years, loneliness has cascaded down through the millennia, an ever-expanding wave of loneliness, powered by itself, by its own terrible self-creating hunger. Confined in bone boxes, we sought solace by rubbing our meat-mounts against one another, and so made more prisoners of bone and flesh to replace us and keep loneliness alive and expanding across the ages.

Now loneliness is only an option, rather than a sentence. Your sentence has been commuted: you are released, not on, but *upon*, your own cognizance. The cell door is open at last: you can walk out any time you are ready. You have been ready since you were born.

And it is safe now. You can leave your cell without fear, without shame, without self-doubt. No matter what horrors you flatter yourself lie uniquely in your skull, no matter what unforgivable deficiencies you claim to yourself, you will find understanding and total acceptance in the Starmind. Everyone else did. One of the nicest things about living in zero gravity is that it is no longer possible

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for one person to look *down on* any other. There is no rank, no class, no racism, in the Starmind. There is no obsession, for there is no need for it. Yet paradoxically, somehow I can look *up to* many of my fellow Stardancers—and look *into* any who consent. All of them, sooner or later.

To join us is *not* to "lose your ego." It is to gain nine billion more. Love on that scale has never been imagined, in all the ages of the world. I tell you that it is better than you *can* imagine.

There is a reason why I have been chosen—out of more than ten billions!—to tell you this story of the final days. And the reason is *not* because I used to practice the writer's trade, although that has proved helpful.

This task fell to me because fate placed me in a unique position. I yearned to live out the rest of my days on Terra so badly that I tore my heart in half, and risked the heart of my daughter, to stay there. Yet I live in the Starmind now, and will live out the rest of my days in space—and am deeply joyous. I have lost *nothing*... and gained the stars.

And more. Buchi Tenmo was quite right about self-generated reality: I still have Provincetown. I smell it as I write.

In fact, I have P-town now far more than I ever did before. For now I can see it through the eyes (through *all* the senses) of Tia Marguerite and Tia Marion and Cousin Tomas and all my relatives and friends, can know it through the perceptions and experiences of every other former resident, nearly everyone living who has ever seen it. If binocular vision creates three-dimensional visual depth, imagine the kind of depth with which I now know my beloved home. Over a hundred years of Provincetown, times millions of people, raised to its own power! I have more of my beloved home than a hundred thousand normal lifetimes could have given me... and I no longer need it. I have much deeper roots, now.

And my husband, who needed the attention of strangers, expressed in dollars, so badly that he tore his heart in half and risked his daughter's heart for it, has more raw attention available to him than he could ever have imagined... and sacrifices *nothing* for it... and needs it not at all.

And his brother, who risked his job and thus his art and thus his life, all to be near him, is now with him always. Just as intimately as I am, for the Starmind understands genetics as no humans ever did. I carry their child in my womb now... a girl who is already Shaping herself, and will begin dancing soon.

That is the reason why I have chosen to tell my own story through more eyes than my own—right up to the moment when all our viewpoints converged.

Can you see that, if any of those three surviving protagonists in the foregoing comedy had known as much about what was really going on as you did when you read their story, they could not have acted as foolishly and destructively as they did? Can you really want to keep wasting as much time and energy as they all did, blun-

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dering through the dark of their lives, squinting through the twin chinks in the bone box and trying to read the hearts of others through theirs?

I/we have also reconstructed Eva's story, and made it part of mine/ours, partly for the additional perspective it adds, and mostly to show that I/we can. Reb knew her, and so the Starmind does, and always will. No one will ever completely die again . . . so long as there is one brain in the Starmind that ever knew him or her. I'm teaching the unborn daughter in my belly about Eva right now—since Rand and Jay are going to give her Eva's name.

"O wad some power the giftie gie us, to see oursels as others see us! It wad frae monie a blunder free us, and foolish notion."

Robert Burns was right. The gift has been given. Take it. . . .

What has happened to our species may seem unprecedented. But it is not. We have made other Jumps of comparable magnitude, up the evolutionary scale. From the sea to the mud to the trees to the mountaintops to the skies . . . and now to space itself, free of the womb altogether.

There is less than no future in being a Neo-Neanderthal . . . for the *next* evolutionary Jump is *already in progress.* A Starmind of six and a half billion brains possesses the necessary complexity and depth to begin to make sense of the Cosmic Background Babble. Deep in the Oort Cloud where the comets play, far from the Sun, something is presently nearing completion that will help, a thing that has no analog in human experience. The infant is listening, learning to hear; one day it will learn to talk. There are as many stars in this Galaxy as there are neurons in a brain: imagine a mind made up of a galaxy of Starminds!

For millions of years, an endless succession of generations of upright, lonely apes have gazed up in dumb yearning at the stars, at the infinite depth and breadth of the Universe, at the teasing promise of the other 99.99999+% of reality. Now, at long last, we have come home.

Join us—as soon as you are ready!

I am Rhea Paixao, and my message to you is: the stars are here. ■

If an animal does something, they call it instinct. If we do exactly the same thing for the same reason, they call it intelligence.

Will Cuppy

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Slag Like Me, Barry B. Longyear, Pocket Books, $5.50, 306 pp. (ISBN: 0-671-79514-7).
Trouble and Her Friends, Melissa Scott, TOR, $22.95, 379 pp. (ISBN: 0-312-85733-0).
Towing Jehovah, James Morrow, Harcourt Brace, $23.95, 327 pp. (ISBN: 0-15-19091990-9).
Summer King, Winter Fool, Lisa Goldstein, TOR, $21.95, 287 pp. (ISBN: 0-312-85632-6).
The Hacker and the Ants, Rudy Rucker, Avon, $20, 307 pp. (ISBN: 0-688-13416-5).
Nebula Awards 28, James Morrow, ed., Harcourt Brace, $24.95, 302 pp. (ISBN: 0-15-600039-3).
Murder in the Gunroom, H. Beam Piper, Old Earth Books (P. O. Box 19951, Baltimore, MD 21211-0951), $15, 243 pp. (ISBN: 1-882968-02-6).
Essential Software for Writers, Hy Bender, Writer's Digest Books (1-800-289-0963), $24.95, 486 + xxvi pp. (ISBN: 0-89879-667-9).

In August, I mentioned that Barry Longyear had written a pair of "Alien Nation" novels. The first, *The Change* (loosely based on a screenplay) was page-turning action-adventure with a message about the power of labeling.

The second, **Slag Like Me,** was a Longyear original, and I consider it much, much better. The original "Alien Nation" TV show was a heavy-handed parable of racism which, Barry assures me, failed because it never really rose above the level of cutesy-poo trivialization. *The Change* was heavy-handed, too, but in a much grittier, realer way. By the time Barry got done with it, there was far too much blood on the ground to consider it anything remotely like cute.

Slag Like Me, on the other hand. . . . Well, heavy-handed ain't the word for it. Barry has rolled up his sleeves, picked up a lead-weighted baseball bat in each hand, and gone after the racism that still persists in our society with all the vim and vigor anyone could ask. It's the sort of thing mainstream America hasn't faced since the days of the original *Black Like Me.*

Do you remember that one? It was not fiction. John Howard Griffin was

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a white man who wanted to find out what it was like to be black in pre-civil-rights America. He took a drug to darken his skin, went out on the street, and learned. So did America, once his book was published. As he wrote:

"The real story is the universal one of men who destroy the souls and bodies of other men (and in the process destroy themselves) for reasons neither really understands. It is the story of the persecuted, the defrauded, the feared and detested. I could have been a Jew in Germany, a Mexican in a number of states, or a member of any 'inferior' group. Only the details would have differed. The story would be the same."

Barry has posited a pugnaciously fair-minded in-your-face journalist who has undergone surgery to make him or her (he denies all labels) able to pass as one of the alien Tenctonese or slags. He has gone out on the street to learn first-hand how humans treat these people, and he has been writing a newspaper column under the name of Ellison Robb (and surely it is pure coincidence if the name reminds us of any SF writer with a similar attitude who once collaborated with Robert Silverberg as Ellis Robertson).

But now he's missed his last two drops. He's disappeared, and the police—familiar characters from *The Change*—must start questioning all those humans (including fellow cops) whom he publicized for their sins of blatant bigotry. Matt Sykes even follows his path of surgery and impersonation to act as bait for the presumed kidnapper and killer.

And then Robb turns up dead. Dissolved in acid. While still alive. Los Angeles, as well as many other cities around the world, erupts in riots. And the search for the killer gains tremendous urgency.

Racism, Barry is at pains to say, is not the only way humans act crazy. There is also addiction, and there we may have an example of hope and redemption. There are recovery programs that work. Indeed, several of his characters are involved in such programs, and in their context the cops find the clues they require to uncover the villain, whose racism is of a quite traditional sort, with an ironic twist.

The end is decisive and satisfying. It also offers a wrap-up statement that puts the responsibility for saving the world from its follies squarely where it belongs:

"What if [everyone in the country] learned that worth comes from within, not from artificial group classifications. . . . It would still be a small drop in a very big ocean of racist insanity where people saw things that were never there and couldn't see things that had stood before them since the slime coughed up its first bit of life. . . . All one can ever change is oneself."

Melissa Scott is not so aggressively out to fix what is wrong with the world. She seems more interested in figuring out how the world works, how its parts fit together, and how those parts and their interrelations must inevitably change with the pas-

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sage of time.

Her latest, **Trouble and Her Friends**, is both excellent and thought-provoking. In it, she focuses on what will happen with the technology of direct brain-computer links, to which much of the rest of the SF community attaches the concepts "cyberspace" and "cyberpunk." These are valuable concepts, she says, representing likely or possible futures, certainly standing for stages in the response of human beings to their technologies. Yet in the real world, those responses do not freeze in a single mode as they have in SF. The world moves on. People and their technologies and the way they use those technologies all grow up. That is, most of the cyberpunk writers and their fans are stuck in adolescence.

Harsh words? Perhaps, and you can even blame them more on me than on her, for I am interpreting her work, not quoting. Yet if we look at the work itself, I think we can see something very like what I just said. The tale opens with a glimpse of the last moments of cyberpunk. There is cyberspace and neural interface, but society has decided that the outlaws must be domesticated. There are laws now, draconian measures that treat anyone caught in possession of a program designed to break through cyberspace security barriers as guilty of armed robbery (your program, your "icepick," is the legal [and perhaps moral] equivalent of a handgun). The days of the lawless frontier are over, though the myth may remain forever.

Trouble is an ace desperado with all the attitude of a Wild West gunslinger, but she can see what is happening. She abandons her partner, Cerise, and vanishes. Cerise, heartbroken at the loss of her friend, lover, and companion, goes to work for a large company, Multiplane, as head of its computer security.

Three years later, someone tries to crash Multiplane's security. The evidence points to Trouble—but not quite. There are discrepancies, and it seems that someone is committing crimes in her name. Her boss tells Cerise, "Get Trouble, or newTrouble, Either one. Fast."

Meanwhile, Trouble is finding the feds on her tail, suspecting her of newTrouble's crimes and not too concerned with the difference—if any—between her and her imitator. The artists' coop for which she works decides it can't afford trouble and releases her. And the gunslinger is back on the street, pissed as hell, looking for the challenger, aiming to protect her rep and reestablish her dominance.

That may sound fairly adolescent so far, but it doesn't stop there. Soon Trouble and Cerise are back together, almost as if they had never been apart though they are now more aware of each other's thorns, and they have tracked their quarry to Seahaven, a cyberspace town presided over by the sinister Mayor; it is also an underworld haven on the New Hampshire coast. The gunslinger metaphor continues, even unto a shootout in the mean main street of virtuality.

This is when Scott makes her point: When an adolescent grows up, he or she becomes an adult, stops challeng-

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ing patterns of order, and works to preserve order. When a gunslinger grows up, she becomes the marshal. A mature cyberspace will not tolerate the antics of the punks.

It's worth noting that this novel contains plenty of internal evidence that Melissa Scott has read Bruce Sterling's *Hacker Crackdown* (reviewed here in January 1993). When I asked, she said she also owes a debt to feminist analyses of the Western.

James Morrow is an inspired lunatic. If you were not convinced of that basic truth by *Only Begotten Daughter* (in which God's daughter was divinely conceived in a sperm bank, sans egg instead of sperm), then **Towing Jehovah** is absolutely, 100%, in spades and hearts too, guaranteed to do the job.

He begins with the idea that God is dead. This isn't a new idea, for it's been around for quite awhile. But no one, ever, has done with it what Morrow has dared.

He begins with Anthony Van Horne, age 50, captain of a supertanker until he slipped up with a superspill. To him appears a bedraggled angel, Raphael, with the word of God's death. Not only that, but God's two-mile-long divine Corpse is floating in the Atlantic, the Vatican has chartered Van Horne's repaired supertanker, a tomb has been carved out of an iceberg up by the Arctic Circle, and if Van Horne will just accept the assignment, he will captain his ship once more, using it as a tugboat to tow God Himself to His rest.

Did you wonder why Raphael was bedraggled? It is God's presence that sustains the angels. Nothing is said of Heaven, Hell, or Satan, but then that last was dealt with nicely in *Daughter*. As for humanity, that Divine creation that most acutely concerns us, well....

Not surprisingly, the Vatican—which hopes that a few Divine neurons will last long enough to be preserved by the Arctic cold—has set a Jesuit to supervise Van Horne and his mission. Soon they have their crew and are on their way. They rescue a determined atheist feminist castaway, Cassie Fowler. They find the Body, hook anchors over His ear-bones, and begin the long tow. And now the fun begins.

Cassie is sure the existence of God's Body is a disaster. It's utter confirmation of the patriarchal conspiracy to suppress womankind, and if the word gets out, the Bad Old Days will come back with a vengeance. Even if God *is* dead. So she convinces the radio officer, a fellow feminist, to sneak a message to her friends back home, one of whom has much more money than sense and promptly uses it to engage a pair of World War II reenactment impresarios to stage the Battle of Midway over God's Corpse with the intent of sending It to the bottom of the sea.

Meanwhile, Atlantis (or a reasonable facsimile thereof) has risen to strand the supertanker in mud. God's Corpse drifts off. The crew, having (of course) lost its moral compass, has given itself over to mutiny and debauchery. The Jesuit hopes (dare he pray?) that Kant's categorical impera-

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tive will kick in in time to save them all. The food is running out. And God's Body returns.

Now the ship's imaginative chef discovers how to ferment God's Blood into wine and turn bits of the Body into—no, not steak or lobster; after all, God's love is for the common people—burgers and chicken nuggets, not to mention bread. The famine is relieved! The crew sets to work to dig the supertanker free. The mission gets on track again, while the Battle of Midway awaits.

There's more, of course. Glory grease is great for aches, pains, and sunburn. Van Horne has problems relating to a stern father. The impresarios are nine nines flako bonkeroso (did I say that?). Cassie is beginning to think that her boyfriend is a bit twitchy himself, and that Van Horne has certain charms.

And then there is that basic question: If the philosophers who said so many years ago that God is dead were right, then why do we still have religion? The thrust of Morrow's impressive satire is his attempt to provide an answer: Yes, he says, we can govern our behavior from other motives (that categorical imperative), but God is a useful concept not least because it provides answers to unanswerable questions of the sort asked by children.

You'll see this one on the award ballots. I highly recommend it.

Lisa Goldstein's newest is **Summer King, Winter Fool,** a fantasy set in a world whose people believe that toward the end of winter, Callabrion, the god of summer, must join his mother Sbona in the sky, and toward the end of summer, Scathiel, the god of winter, must take the throne. Their perpetual exchange ensures the cycling of the seasons and the welfare of humanity.

The scene is Etrara, a city-kingdom whose king was assassinated some time back by his illegitimate kids. One of those kids now rules, or misrules, the city. His sibs chafe and plot to replace him. Meanwhile the courtier Valemar is baffled by the circumstances that have exiled him to a city notable mainly for its past (it was destroyed in a war of poet-mages) and its library, where Etrara sends all its birth records (then why can't Valemar find his own?).

Etrara's throne changes hands. Valemar returns, somewhat spoiled by rustication for the games of courtiers. Winter stretches on, even after Callabrion's supposed ascent. The new queen declares a war on a neighbor that promptly defeats Etrara. Valemar learns something of war, love, and magery and—this is no surprise—is revealed as the One True Heir to the kingdom. Callabrion turns out to have fallen in love with Earth; winter has settled in to stay because he is shirking his duties. And, of course, all comes right in the end.

There is a point to this one, having to do with responsibility and acceptance and the rhythms of existence, but I have to say I think it the least of Goldstein's books to date, not really worthy of the author of *Strange Devices of the Sun and Moon* or *A Mask for the General.* Wait for the paper-

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back, or wait for her next.

The other day, Hans Moravec sent me the almost complete manuscript of his next book, *Mind Age*. From what I've read of it so far, it's a fascinating look into the future of a very SFnal field, much as was its predecessor, *Mind Children,* and I will very definitely review it in the next month or two.

I mention it at all now because I've just finished reading Rudy Rucker's **The Hacker and the Ants,** and it would be interesting to review the two books side by side. After all, both are talking about the same sorts of things, even though one is fact, the other fiction. And—perhaps strangely—the nonfiction is the better read.

That is, Rucker's new novel is not terribly enchanting. Most of the problem lies in the first 50 or 60 pages, where he introduces his protagonist, Jerzy Rugby, hacker supreme, and describes his work for GoMotion, Inc.: writing the software for a robot able to navigate about the home and do chores without mistaking the baby for the turkey awaiting the oven. To put it better, he is "evolving" the software, following the basic principles now being laid down by "artificial life" researchers who are already showing how a kind of "natural selection" can come up with schemes that surpass what humans can devise.

Now this is nifty stuff for a novel, but Rucker has chosen to present it as such a huge and indigestible "expository lump" that I was tempted several times to give up in disgust. However, I stuck it out until the ants—apparently escaped from GoMotion's virtual ant farm—showed up in Jerzy's cyberspace. Here is hazard enough to complicate a life already confused by impending divorce, mass invasions by realtors, strange encounters of a feminine kind, Vietnamese immigrants who wish to sell him cheap chips, and more. A mysterious cyberspace figure that calls itself HEX DEF6 tells him to go to work for a company that specializes in ripping off its competitors, he is fired, the ants invade worldwide TV, he is accused of treason. Before long, his only out seems to be to flee the country for Switzerland, where his erstwhile boss has holed up.

What is going on here? That's the mystery, of course, and I shouldn't give too much away beyond this: the ants' escape is no accident, and everything that happens is directed toward a single higher goal. Things don't really turn sour until after Jerzy gets to Switzerland, where he turns out to be on just the right spot at just the right moment to save the world as well as learn just what he must to solve his legal troubles.

You won't find it easy to get over the lump in Rucker's expository road, but if you do, the story stands a good chance of satisfying.

James Morrow's third and last volume of the yearly anthology that showcases what the Science Fiction and Fantasy Writers of America think is the cream of the SF&F crop is upon us. He will be succeeded by Pamela Sargent, noted SF novelist and anthologist (the *Women of Wonder* series).

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In his introduction to **Nebula Awards 28,** Morrow asserts that most of the fiction here says something about the nature of science. I'm not sure how impressed I should be at that observation, for it seems to me both that a great deal of SF has always dealt with the nature of science and that Morrow stretches a bit to find profundity in some of the stories.

Be that as it may, the book offers an excellent overview of 1992. David Lunde's "Song of the Martian Cricket" won the Rhysling Award for best short poem. The Nebula-winning short story, Connie Willis's "Even the Queen" is accompanied by others from the Nebula ballot (by Michael Bishop, Paul Di Filippo, Nancy Kress, and Kim Stanley Robinson). For novelettes, there are Pamela Sargent's Nebula-winning "Danny Goes to Mars," Gregory Benford's "Matter's End," and S. N. Dyer's "The July Ward." For novella, here's Morrow's own "City of Truth"; it won the Nebula in its category, so don't knock him for conflict of interest.

What else is here? Nick Lowe overviews the year's SF&F films. John Clute's "Is Science Fiction Out to Lunch?" does the same for novels. Both seem impatient for SF to get about the task of reinventing itself. Looking further back, Poul Anderson, David Hartwell, and Stephen King memorialize the late Fritz Leiber. And an excerpt from new Grand-Master Frederik Pohl's 1979 autobiography, *The Way the Future Was,* gives us a glimpse of fandom's early days.

Every school and town library in the country (and beyond) should have this series. So should everyone who wants to keep up with the field.

So get thee to a bookstore, go. They're saving one just for you.

H. Beam Piper wrote a great deal besides the Little Fuzzy books, and much of it appeared in this magazine back when it was *Astounding,* beginning in 1947. His first novel was not SF, however, but a murder mystery called **Murder in the Gunroom** (1953), in which a wealthy gun-collector is found dead, an antique revolver in his hand. The coroner's verdict is "death by accident." The widow engages detective and pistol-collector Jeff Rand to prove otherwise.

I don't think Piper ever failed in his writerly duty to keep the reader turning pages. It is therefore a pleasure to be able to tell you that Old Earth Books has reissued his first novel and hopes to be able to bring out the Little Fuzzy tales in hardcover.

If you are a writer (of fiction, nonfiction, poetry, scripts, screenplays, or business reports), wish to be a writer, or are interested in writing, you will find Hy Bender's **Essential Software for Writers: A Complete Guide for Everyone Who Writes with a PC** a book worth buying. If you are just starting out as a writer and are still trying to decide what sort of computer software will help you achieve your dreams, you will find it an absolutely essential purchase, if only because it includes discount coupons that offer you some huge savings. The benefit comes to a full

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$2000 if you use them all, but if you use any of them, you save more than the price of the book.

Now that's not a bad deal. But the book would be worth its price even without the coupons. What Bender has done is to look at nearly every possible category of MS-DOS (nothing for Macs) writer's-aid software—from word processors through idea generators, dictionaries, thesauruses, grammar and style checkers, data retrievers, encyclopedias, language translators, and more. He discusses the several on-line computer services and specialized tools for lawyers, doctors, scientists, engineers, students, and academics. He covers virus detectors, utilities, file conversion, and desk-top publishing.

In each case, he looks at several of the most popular members of the category, describes how they work, and tells you which ones he likes, and why. As examples of his calls, he's rather skeptical of grammar checkers in general ("It's likely that you won't agree with much of what these programs tell you about your documents [*especially* if you write well]"), he loves the CD-ROM version of the *Oxford English Dictionary* ($895, no discounts), and his favorite word processor is XyWrite. Can you trust him? Well, his description of the OED makes me drool, I think a grammar checker would drive me nuts, and I love XyWrite too. That's enough for me, though there's plenty more.

The book is not comprehensive. It does not cover every available word processor, idea generator, or encyclopedia. It doesn't mention digital publishing tools at all. But within its limits it will serve anyone as an excellent guide to choosing useful software. This is one I plan to keep. That way, if I ever need to write a script, I will know that the best package is Scriptware. I will know the best dictionary, considering price and hardware requirements, is the Random House Webster's Electronic Dictionary & Thesaurus. When I get a CD-ROM drive, I will know which encyclopedia (Microsoft's Encarta for Windows), literature compendium (Library of the Future), crib sheet (the complete Monarch Notes), and atlas (Software Toolworks or DeLorme) to get. I'll also know where to get them, for Bender supplies all necessary addresses and phone numbers.

Should I mention that Bender has also sprinkled scores of writerly quotations matched to antique clip art throughout the book, just to keep this compendium of reviews from getting too dry? Now I have, and I will keep you no longer from dashing out to get your copy. ■

If a learned man is not balanced, his learning does not avail.

—Anon Author: Insinger

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BRASS TACKS

Dear Stan,

Some comments on your February editorial "Mega-choice." I wrote an article for the April 1955 *Astounding* called "The Right To Breed" under the direction of John W. Campbell, who ordered me to irritate the hell out of his readers by taking the point of view of a fanatic who believed that God had ordered mankind "to be fruitful and multiply" and that therefore birth control was a sin. He confessed in an editorial called "The Fanatic" in July 1955. In 1955 the Earth's human population was less than half of what it is today.

This old article has some bearing on Paul Birch's claim (August '93) that "Even on Earth current technology would allow population to grow by at least a factor of 40,000." A calculus student once made such a claim in my class, so I set the class this problem.

Build a habitation shell around the Earth, covering land and ocean, five kilometers thick. Give each person a space allowance of $23 \times 23 \times 23$ meters. From this allotment each individual must contribute a volume share for the structure needed to support the shell, a share of the plumbing and water reservoir, of the fusion power plant, of the fiber optics and switchboards needed for communication, a share of the parks and corridors and elevators and warehouse and factory and mine and farm space, a share of the sewer system and public toilets, as well as whatever that individual needs for his rose garden, garage, couch, closets, book space, lamps, kitchen and refrigerator and old love letters.

The problem:

(1) What is the final population?

(2) How long will it take to fill up this world at an increase rate of (a) 1 percent per year, (b) 2 percent per year, (c) and at a 40 year doubling rate, approximately the doubling rate of human population during the twentieth century.

Answers:

(1) Elementary arithmetic and the Earth's radius gives a "no-vacancy" population of about 200 trillion people.

(2a) At an increase rate of 1 percent per year, this population is reached in 1,000 years.

(2b) At an increase rate of 2 percent per year, our shell is filled in 500 years.

(2c) At the twentieth century's rate of increase, our five kilometer tall hotel is filled after 600 years.

My best students got those answers easily—and couldn't believe them because they had been brought up with minds that made linear rather than exponential projections. I suspect that Mr. Birch does not have a

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command of elementary calculus. Knowingly or not, when a pope or a Paul Birch advocates limitless growth they are advocating mass murder, crime and violence, pestilence, mass insanity, and cut-throat survival.

In my article I estimated that, with some hot-shot tech and a faster-than-light drive (say a billion light-years per day) plus twentieth century rates of increase, humanity could convert the entire mass of the Universe into human bodies within 7,000 years. If there is actually enough dark matter present to make the Universe collapse, humanity would be slowed down a bit—it might take them 7,600 years to eat the Universe and convert it into human babies who, perforce, would have to become cannibals. Space has essentially a zero capacity to absorb population.

While I'm at it let me rant and rave about Steve Gillett's and Brett Bellmore's Dec '93 Brass Tacks critique of de Camp's "Goat Island" (April '93). Yes, it is true that certain classes within technologically "advanced" societies like the US and Europe do have stable or declining birth rates. So what? We can cite the birth rate of spinsters to "prove" that populations are going to stabilize. The Amerindian society had a stable population. However . . . the Kingsburys, who arrived in Boston in 1635 and had an average of eight children per generation didn't. Goodbye Amerindians.

The significant *fact* is that American and European populations are *not* declining because they are wealthy. Their populations are increasing rapidly because they are attracting immigrants. This *temporarily* takes the pressure off poor regions. Can Gillett or Bellmore give me an example of a rich nation surrounded by rapidly breeding poor nations whose population has stabilized? It doesn't happen because the poor move toward the rich.

Gillett has been captured by a lethally fallacious meme. "The way to cap Mexico's population is to let them become wealthy, too!" It won't work. As soon as the Mexicans become wealthy, immigrants will pour into the country from poverty-stricken South American countries. This meme is old and tired. In 1910 the Gilletts were predicting that the world's population would cap at two billion by 1950. In 1950 the Gilletts were predicting that wealth would cap the Earth's population at five billion by 2000. Just last week I read a prediction that the Earth would be so rich by 2025 that its population would be capped at ten billion!

"Make everyone on Earth rich!" is the battle cry of this meme. Yeah. The problem is we are inserting a hundred million new humans into the ecology every year. Just to take these people up to American levels of health and welfare we have to build the equivalent of a whole new American infrastructure every three years—cities, roads, hamburger stands, a new Las Vegas, slum schools, and 200 million new guns. All without chopping down any more forests or lowering the groundwater level or stealing water from the Colorado. And that does nothing for the 5.3 billion people who are already here.

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Is this kind of massive wealth creation happening? No. There are local hotspots that are growing more wealthy. Since Gillett and Bellmore and Birch probably live in one of those hotspots, it is easy for them to believe, by using a biased statistical sample, that this is happening everywhere—Mexico just has a longer way to go. It just isn't so.

Since I wrote my article for Campbell the human population has more than doubled. That means we have spent the last 40 years struggling (and not succeeding) to duplicate the world's infrastructure—rather than making ourselves richer and more civilized. Those who think the New York or the Mexico City of 1994 is better than the New York or the Mexico City of 1955 are just plain crazy.

Current technology is not keeping up with the population increase. Much of our "new" wealth isn't new wealth at all, it is capital—like groundwater and oil. Sure nanotechnology and hydrogen fusion are going to save us—probably *after* the great population crash of the 2030s when seven billion people die in a decade of infrastructure collapse à la Somalia.

Gillett has the cart before the horse. Wealth doesn't produce a stable population. It is a stable population that generates wealth.

DONALD KINGSBURY

Dear Stan:

Clearly the inability to refer to mental, emotional, and physical deficits as "challenges" is itself a deficit. People so afflicted are a distinct and identifiable subgroup: a minority. As such, they are entitled to society's protection from the derision, conscious or otherwise, intrinsic to adjectives such as "bigoted," "ignorant," "rude," "unenlightened," "unmannerly," et cetera, which so often are applied to people who exhibit this type of behavior.

In the wake of your editorial and the response it generated, it is not only appropriate but politically necessary at this point that *Analog* go on record in support of the proposition that it is politically incorrect to criticize or ridicule the euphemistically challenged. . . .

Thank you.

DAVID R. PALMER

Dear Dr. Schmidt,

I have this gut feeling that the February 1994 *Analog* will be remembered for a very long time.

Leon O. Billig's science fact article on hurricane control excites me. Ever since E. E. Smith described "force planes" in his Galactic Patrol series, I have thought of how they could be used to create artificial weather fronts, which would force warm moist air to climb up such a plane and thereby cool and dump its moisture wherever rain was needed.

Now it turns out we don't have to wait for force planes to be invented. Today's technology will do it better! And best of all, it can be done by harnessing the natural energies in the atmosphere, instead of expending huge amounts of energy to maintain the planes against the force of the wind.

I was curious why it was necessary to break the problem down into seg-

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ments 1,000 meters high, in order to calculate stresses, etc. If my dim recalls of freshman calculus are correct, Newton took such segments and made them more numerous and smaller, until the result was a smooth curve. Can it be that no one has yet derived a formula that describes how steel reacts to stresses and supports its own weight in tall structures? Of course, Mr. Billig's approach may have been deliberately "quick and dirty" in order to explore the concept's feasability, and I do not criticize him for this. But I would like the point explained.

Some further thoughts:

A series of such structures along the Gulf Coast, 50 miles apart, could alter the weather patterns for most of the country east of the Rockies. By keeping the humidity no higher than, say, 50% over the region that is presently fed by moisture from the Gulf, we could prevent future flooding of the entire Mississippi River basin, and generally control the weather patterns of that huge area.

How could such control be achieved? It appears that the only modifications to the proposed structures might be to make them another 1,000 meters taller, and perhaps of a greater diameter, along with huge doors or "weirs" to modulate the flow of air at the intakes. These would be closed as needed to prevent icing at the top or to keep the air moist enough to prevent creating a huge desert in the Corn Belt.

I look forward to seeing computer models of such a plan, which would show just what is needed to control the weather under any circumstances. I'm sure the National Weather Service already has such models in use, so that plugging in the "what if's" of the effects of the proposed series of structures would be a trivial task. But we need simplified models that will run on home computers, so that thousands of people can play with the idea.

We will also need computer models of the structures themselves, so that simulated wind forces can "test" the models to destruction and show the effects of various heights, diameters, modulated air flows under varying surface temperatures and humidities, etc. How low do the jet streams get, and would the towers tend to attract them?

Why not extend the idea up the entire Atlantic Coast from southern Florida to as far north as computer models will predict effective control? And would it work in the Seattle area, to make it a bit drier there?

What Mr. Billig describes inside his structures is the equivalent of a natural thunderstorm. It would appear that static electricity would therefore be generated in non-trivial amounts. Any lightning bolts would of course be grounded out in the steel structure itself—but wait! What would happen if we put an insulating ring at the base of the structure, or between segments at the 1,000 meter level? Then we could bleed off the static electricity and perhaps put it to use to supplement the water power. An average lightning bolt I understand involves something on the order of 10,000 amperes at 10 million

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volts—a total wattage, even if intermittent, not to be sneezed at. Harnessing these energies and smoothing them out suggest another set of computer models for study. And how do we prevent the torrents of water from shorting out that extra power?

Viva technology! My profound thanks to Mr. Billig for a fascinating and eye-opening article. And, oh yes, reserve me a condominium at the 5,000 foot level, facing south near Gulf Shores, Alabama, and within walking distance of the Heliport!

DON C. MAIER

Enterprise, AL

The author replies . . .

Mr. Maier recalls his freshman calculus correctly. If the structure had only to withstand its own weight, or if wind loads could be described by a simple mathematical function relating force to height, the required wall thickness would take a logarithmic form. Then the only problem would be to find a mill to deliver logarithmic steel. I divided the structure into 1000-meter segments because I was too lazy to write a computer program that could divide it into 1-meter segments. This is indeed "quick and dirty" but it is the way virtually all preliminary design is done.

As the ambient humidity drops, circulation through the chimney will slow. Everything hinges on condensing sufficient moisture to heat the air inside the chimney enough to overcome the local temperature inversion. I haven't calculated the minimum humidity needed to drive the process, but 50% may be too low. It depends on other variables, especially ambient temperature. And a "Standard Day" atmosphere is a more or less arbitrary fiction defined to provide a consistent basis for designing, among other things, aircraft.

Mr. Maier has touched on some perturbations of the concept worthy of exploration. The possibilities are far too numerous to discuss here, but I suspect the economics of my design could be vastly improved. In particular, air turbines would likely generate far more power than water turbines driven by falling water. As for using the chimneys for large-scale climate control, the thought of the political battle that would touch off makes me cringe.

LEON O. BILLIG

Dear Dr. Schmidt:

I greatly enjoyed Steven Burns's "Song from a Broken Instrument" (February). One question does nag, however: since the samplings of Topaz Baldwin's voice were taken from the time between her twentieth and thirtieth birthdays, can we assume that her voice would never change?

Who could not keep from rising in that standing ovation for Topaz at the Grammy ceremony? Yet I think that, a few years down the line, her fans and critics would begin to look upon her as some kind of freak. The older she got, the worse the dichotomy between age and vocal sound would become. If I understand the story correctly, her speaking voice also would remain that of the twenty-something Topaz.

Given the choice among muteness, a robotic voice, or a few further glorious years of output, the choice appears obvious. But I would like to know the author's thoughts, since

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he is clearly implying that we will have the capabilities outlined in his story in only a handful of years.

ALAN CLIVE

143 Fleetwood Terrace
Silver Spring, MD 20910-5563

The author replies....

Dear Mr. Clive,

I'm glad you enjoyed "Song." Your questions caught me by surprise, but I'll see if I can answer them. I think maybe I might be able to satisfy you on some points, but probably not on all of them.

I don't see that there would be much of a problem with Topaz sounding "too young" as she got older because of the age she had been when she sang the samples her regained voice were based on. There are several reasons for this.

First, while samples are the basic materials for the sound ultimately produced, they aren't played over and over and exactly the same each time like an answering machine message tape. They are sound pieces which, like the notes on the page, can be translated into the sound of a piano, an oboe, an electric guitar, a violin, a voice.

Next, except during live performances we very rarely hear a singer's voice precisely as it comes from his or her mouth. The vocal track we hear on a recording is to one degree or another an artificial construct. It has been filtered and contoured and tweaked and modified by a variety of means to make it fuller, sweeter, richer, cleaner. Digital recording techniques only make this processing easier and more probable. In this case Topaz's recorded voice would be different from that of others only by how much processing it has undergone.

Some voices age better than others. It occurs to me that there seems to be something like a bell-shaped curve at work, short and steep for some wide and long for others. Many times when a voice ages there is a resulting loss of range; but quite often this is compensated for by an increased depth, and better control of it as an instrument.

Topaz would have a control over how her voice sounded which many singers would kill for—and some might even duplicate. Overtones and shadings a natural voice could never hope to produce would be hers for the asking, giving her access to effects others could only achieve through studio processing. Voices built from scratch and allowed to be heard the way hers is might well become an artform in itself.

Last but not least, the best artists are quite often their own sternest critics. I'm sure if her voice began sounding "wrong" she would hear it and take steps to rectify the problem long before anyone else heard it—and if she didn't, I'm positive Cass would point it out to her.

As to whether she might come to be regarded as a freak in later years, I cannot say. The electric guitar was once considered a gimmick, as was the synthesizer. You can never really know what will kick off a trend, become part of the mainstream, or start a backlash. Beyond that, fame is a fickle thing, and even the best artists can lose their audience. I suppose I'd have to look in on her at that point in her life.

STEPHEN L. BURNS ■

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UPCOMING EVENTS Anthony Lewis

28-30 October

WORLD FANTASY CONVENTION at Clarion Hotel, New Orleans, La. Guests: William Kotzwinkle, George Alec Effinger, George R. R. Martin, Tim Powers. Registration—$30 supporting. Limited to 1000 members. Info: World Fantasy Convention 1994, Box 791302, New Orleans LA 70179-1302. (504) 769-3766.

4-6 November

CONTRADICTION 14 (Niagara area SF conference) at Days Inn Fallsview, Niagara Falls, N.Y. Guest of Honor —Mike Resnick; Special Guest—Janet Kagan. Registration—$21 until 15 October; $25 thereafter. Info: Contradiction 14, Box 100, Bridge Station, Niagara Falls NY 14305-0100.

18-20 November

PHILCON 94 (Philadelphia area SF conference-oldest in the country) at Adam's Mark Hotel, Philadelphia, Penna. Principal Speaker—Larry Niven; Guest Artist—Jim Burns. Info: Philcon 94, Box 8303, Philadelphia PA 19101. (215) 957-4004. GEnie R.Kabakiian

25-27 November

LOSCON 21 (Los Angeles area SF conference) at Airport Hilton, Burbank, Calif. Guest of Honor—Lois McMaster Bujold: Artist Guest of Honor—Alicia Austin; Editor Guest of Honor—Kristine Kathryn Rusch; Fan Guest of Honor—Robbie Cantor. Info: LASFS, 11513 Burbank Blvd., North Hollywood CA 91601.

24-28 August 1995

INTERSECTION (52nd World Science Fiction Convention) at Scottish Exhibition & Conference Centre, Glasgow, Scotland. Guests of Honour—Samuel R. Delany & Gerry Anderson; Fan Guest of Honour—Vin¢ Clarke; TMs—Peter Morwood & Diane Duane. Registration—£60/US$95/CDN$120/DM160/DFI 180 until 30 September 1994. Supporting—£15/US$25/CDN$30/DM40/DFI 45. At-door rates not set as of the time of this listing but will be greater than current attending rates. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Join now and get to nominate and vote for the Hugo Awards and the John W. Campbell Award for Best New Writer. Info: Intersection, AdMail 336, Glasgow G2 1BR, UK: Intersection, Box 15430, Washington DC 20003-4030, USA.

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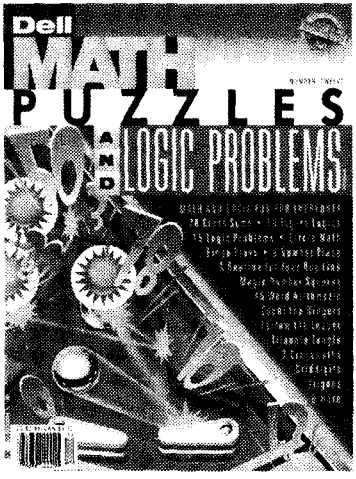

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